MADRAS JOURNAL

OF

LITERATURE AND SCIENCE.

No. 29—October 1840.

I.—*Catalogue of the Birds of the Peninsula of India, arranged according to the modern system of Classification; with brief Notes on their Habits and Geographical Distribution, and description of new, doubtful and imperfectly described Species.—By* T. C. Jerdon, *Assistant Surgeon, 2d Madras Light Cavalry.*

(*Concluded from No.* 28 *page* 15.)

Ord. GRALLATORES.—*Waders.*

Family ARDEADÆ.—*Cranes* and *Herons.*

Genus GRUS, L.—*Crane.*

I shall commence this family with the *Cranes*, which have been accidentally omitted in Swainson's Synopsis.

297.—*G. Antigone*, Edw. pl. 45.—*Sarrus*, H.—*Greater Indian Crane.*

I have only observed this fine bird once or twice on the banks of the Godavery and Kistnah rivers, but extract from Mr. Elliot's notes the following excellent observations, chiefly made in Guzrat, it being but a rare visitant to the Southern Mahratta Country.

" The *Sarrus* lives always in pairs, though several pairs are frequently seen together, and occasionally, though rarely, a stray bird, either a young one, or one that has lost its mate, with another pair. Every morning they are seen at sun-rise winging their way to the cultivated fields, to feed upon grain, their sole aliment—and about 11 or 12 o'clock, they make their way to the nearest water to drink, always preferring the sandy beds of rivers, where they are seen in the greatest numbers, but not disdaining to resort to tanks, should no stream be near. There they remain all day, and at evening again, betake themselves to the fields, returning to pass the night by the water side. When alarmed and when on the wing in the morning flights, they utter a fine clear trumpet-like note."

The *Sarrus* is migratory, appearing in the Peninsula only in the cold weather.

Irides vinous red; bill pale sea green, brownish at the tip; legs rosy red, passing into brown in front. Length 52 inches; expansion of wings 7 feet 9 inches; tarsus 13; bill 6; weight 17 lbs.

From the testimony of Shikaries and others, there appears to be another large *Crane*, which occasionally visits the Peninsula, and from the descriptions I have heard, it is probably the *Grus Torquata* of Vieillot and Wagler.

298.—*G. cinerea.*—*Ardea Grus*, L.—*Koolung*, H.—*Common Crane.*

The well known *Crane* is found in India in the cold season only, living in pairs or small parties of 6, 8, or more. Has similar habits and food with the *Sarrus Crane.* On one occasion I found the flowers of the Koosoom (*Carthamus tinctorius*) to have been the only food partaken of. This was late in March when most of the grains were cut. The *Koolung* is often seen in company with the next bird.

Irides reddish yellow, brown in some; bill sea green; legs black. Length 3½ feet; expansion of wings about 6 feet; tarsus 8½; bill at front 4.

Sub Genus ANTHROPOIDES, Vieillot.

299.—*A. Virgo.*—*Ardea Virgo*, L.—*La Demoiselle*, Buff. P. E., 241. —*Kurronch*, H. also *Kurkurrah.*—*Kurkoncha*, Can.; all named from the call of the bird—*Demoiselle Crane.*

This most elegant, and chastely coloured bird is found over most of the Peninsula, during the cold weather, and in much greater numbers

than either of the two last *Cranes.* Like these it is most abundant in the neighbourhood of the larger rivers, and has similar habits and food.

Mr. Elliot in his notes says " Flies in vast flocks—from 50 to 100, and even 500, with great regularity of arrangement, in a long line, a few of the leading ones disposing themselves in another line at an angle, varying from a right to an acute one with it. This is when they are in progress—at other times, as when disturbed during the heat of the day, they may be seen circling round at a great height, but still a regular order of lines may be distinguished. Their favourite food is chenna (*Cicer arietinum*). They never go to tanks to drink but always to rivers." When this bird is struck by a *Bhyree* (*Falco peregrinus*) its mate generally comes to its assistance. The *Bhyree* always strikes it on the back and wings, to avoid being wounded by the sharp inner claw, with which, if struck on the head, it generally manages to inflict severe wounds on the breast of the falcon.

Irides fine vinous red; bill greenish at the base, yellowish in the middle, and inclining to pink at the tip; legs black. Length $2\frac{1}{2}$ feet; expansion about 5 feet; tarsus $6\frac{1}{2}$ inches; bill to front $2\frac{3}{10}$ths.

The inner claw of all these *Cranes* is much hooked, and exceedingly sharp, and it always in self-defence strikes with its claw and never with its bill.

Genus ARDEA, *Heron.—Buglah*, H.

Sub Genus ARDEA, Swains.

300.—*A cinerea*, Lath.—*A. major*, Gmel.—*Kabood*, H.—*Common Heron.*

The European *Heron* is found all over India throughout the year, frequenting tanks and rivers. It is generally solitary, but is occasionally met with in parties of 4 or 5 together. It breeds in the more wooded districts on the top of lofty tress, during the hot weather, generally 4 or 5 nests being placed together. Length 3 feet; bill at front $5\frac{2}{10}$, at gape $6\frac{1}{2}$; tarsus $6\frac{1}{2}$; centre toe and claw $4\frac{3}{4}$; hind do. $2\frac{1}{2}$.

301.—*A. purpurea*, Auct. also *A. purpurata.*—*Naree*, H.—*Purpled Heron.*

This species is much less numerous, and less generally spread than the

last one. I have seen it most abundant in the wooded western coast in the wet paddy-fields. It is also a permanent resident in India, but I have not yet seen its breeding places.

Irides yellow; bill brown above, yellow beneath; legs yellow, brown in front. Length 30 to 32 inches; bill to front $4\frac{8}{10}$ths inch, at gape nearly 6; tarsus 6; centre toe and claw nearly 6; hind toe $3\frac{1}{2}$.

Sub-Genus EGRETTA, Briss. Swains.

302.—*E. flavirostris.*—*A. flavirostris*, Temm. and Wagl.—*A. Torra*, Buchanan and Franklin.—*A. egretta*, Sykes' Catal.—*Mullung Buglah*, H. —also *Turrur Buglah.*—*Larger Egret*—*yellow-billed Egret.*

This bird appears to have been first described as distinct by Buchanan (according to Franklin), who named it *A. Torra*—and when without the appendages, *A. putea.* It has, however, been since named by Temminck with a more scientific appellation, which I have therefore adopted.

The large yellow-billed *Egret* is tolerably abundant in most parts of India, frequenting rivers, tanks, marshes, and the inundated paddy-fields.

Length nearly 3 feet; bill at front 4 inches, at gape 5; tarsus $5\frac{1}{2}$; bill yellow; legs black.

303.—*E. alba.*—*A. alba*, Gmel., Lath. and Wagler?—*A. Egretta* of Temm. and others?—*Puttoka Buglah*, H.—*Large black-billed Egret.*

Though I have not hitherto obtained specimens of the large *Black-billed Egret*, I have on several occasions observed it in different parts of the country, always alone. It is probably the *Egret* of Europe, said to be found in numbers in Central Asia.

304.—*E. Garzetta.*—*A. Garzetta*, Auct.—*Keerchea* (or *Kilcheeah*) *Buglah*, H.—*Small Egret.*

This *Egret* abounds over all the Peninsula, occasionally associating in numerous flocks, and frequenting rivers, tanks, paddy-fields, pools of water, &c. &c.

Irides light yellow; bill black; legs do.; feet greenish yellow. Length about 2 feet; bill at front $3\frac{2}{10}$th inch; at gape 4; tarsus 4. It is said by the natives that the bones of this bird, if reduced to powder, and a little employed in the cooking of bony fishes, render the fish bones quite soft, so that they can be eaten with satisfaction!!

305.—*E. asha.*—*A. asha*, Sykes.—*A. jugularis* of Forster and Wagler?.—*Kala Buglah*, H.—*Small blue Heron.*

This is a comparatively rare bird. I have seen it but once or twice solitary in small rivers, in the northern part of the table land. My only specimen differs somewhat from Colonel Sykes' description, in having the whole under surface of the body grey, dashed slightly with white on the neck and lower part of the body, chin and throat alone are pure white. It appears to resemble much the description of *Ard. jugularis*, but Sykes pronounces his bird distinct, so for the present I place my specimen under his appellation, as the only recorded similar Indian species. Mr. Elliot in his notes says, " Is common on the western coast at the mouths of rivers."

Irides light yellow; bill brownish horny above, yellowish beneath; legs greenish black; feet greenish. Length about 2 feet; bill at front $3\frac{1}{2}$; at gape $4\frac{2}{10}$ths; tarsus 4.

306.—*E. Javanica.* Sw.—*A. Javanica*, Horsf.—*A. Scapularis*, Wagl. —*Kunchur Buglah*, H.—*Indian Green Heron.*

This pretty little *Heron* differs according to Horsfield and Swainson from the closely allied South American bird (*Ard. Scapularis*) in the comparative length of the toes, and in the legs being feathered close down to the knee. It is only found solitary on the banks of wooded streams, perching in general on a low branch overhanging the water. It is spread over all the Peninsula.

Irides light yellow; bill blackish above, yellowish horny beneath; legs dark green; feet yellow; lores light green. Length 17-18 inches; tarsus nearly 2; bill to front $2\frac{4}{10}$ths, at gape $3\frac{1}{2}$.

307.—*E. Malaccensis.*—*Ard. Malaccensis*, Auct.—*A. Grayii*, Sykes, Hardw Ill. Ind. Zool.—*A. affinis*, Horsf.?—*A. Coromandelica*, Lich.?—*Buglee*, H. also *Undhe Buglee.*—*Marroon-backed Heron* or *White winged Heron.*

The supposed new species of Colonel Sykes, named by him *Ard. Grayii*, I have ascertained to be the summer or breeding plumage of the common *Ard. Malaccensis.* It begins to moult in April or May, and resumes its plain winter livery about September or October. Perhaps the most remarkable circumstance connected with this is the change of colouring the bill undergoes, from the usual plain dusky tint to the three coloured hues it presents during the hot season.

The *Buglee* is a very common and familiar bird, frequenting rivers, tanks, marshes, wet paddy-fields and pools of water—and often seen in the rivers, feeding among crowds of people, bathing and washing, with-

out any alarm or suspicion. It is often struck down by a trained Shikra (*Accip. Dukhunensis*).

Irides light yellow; legs and feet light greenish. Length 19 inches; bill at front $2\frac{1}{2}$, at gape $3\frac{2}{10}$ths; tarsus $2\frac{3}{10}$th inches.

308.—*E. Caboga.*—*Ard. Caboga*, Pennant.—*A. ruficapilla*; Vieill. ?—*A. russata*, Wagler ?—*Dorreah Buglah*, H.—*Soorheah Buglah* of some.—*Cattle Heron.*

This well known species is generally found in flocks of various size in company with herds of cattle, feeding on grasshoppers, and other insects disturbed by them whilst grazing. It seldom resorts to water like its other congeners, except during the heat of the day. Like the last, it assumes its beautiful golden or ruddy tint on head, neck and back, only during the breeding season.

Irides bright yellow; bill dark yellow; legs and feet blackish. Length about 20 inches.

The specific name is derived from the Hindustani '*Gao Buglah*', meaning *Cow Heron.*

Sub Genus BOTAURUS, Briss.—*Bitterns.*

309.—*B. cinnamomeus.*—*Ard. cinnamomea*, Gmel.—*Lal Buglah*, H. of some.—*Little Chestnut Heron* or *Bittern.*

I have only found this little species at all common on the wooded regions of the western coast, generally in marshy ground, or in the wet paddy-fields. I have also seen it on the banks of the Pykarra river on the Neilgherries, and Mr. Elliot mentions it as common in parts of Dharwar.

Length about 15 inches; bill at front 2, at gape $2\frac{7}{10}$ths; tarsus $1\frac{9}{10}$ths,

310.—*B. Stellaris*, Briss.—*Nir Goung*, H.—*Common Bittern.*

I have not myself hitherto procured a specimen of the *Bittern*, but know that it has been killed near Jaulnah and Aurungabad, in marshy ground. It is enumerated, moreover, both in Sykes' Catalogue and by Mr. Elliot, and the latter gentleman has lately shown me a fine specimen shot on the Neilgherries, during the hot season.

Sub Genus NYCTICORAX, Steph.

311.—*N. Europæus.*—*Ard. nycticorax*, L.—*Wākh*, H.—*Night Heron.*

The *Wākh* is of universal occurrence throughout the Peninsula,

but most common in the more wooded regions. It roosts during the day on high trees, often in palm groves, and sallies forth to the waters in the neighbourhood after sunset to feed upon fish, frogs, and other aquatic animals. It breeds on palm and other trees, many nests together. Its Hindustani name is derived from its harsh call.

Irides crimson. Length 21 to 23 inches; tarsus 3; bill at gape 4, at front $2\frac{8}{10}$ths.

Genus PLATALEA, L.

312.—*P. leucorodia*, L.—*Chumuch Boozah*, H.—*White Spoonbill.*

The *Spoonbill* is tolerably abundant over India, frequenting rivers and tanks, occasionally in numerous flocks, and feeding on various aquatic insects, *crustacea*, small fish, &c.

The Hindustani name signifies '*Spoon Ibis*,' and I think from its manner of feeding, its small gape, and its flight, the *Spoonbill* shews more affinity to the *Ibis* family than to that of the *Herons*, with which most authors associate it.

Genus CICONIA, Briss.—*Storks.*

Besides the *Mycteria*, already separated from the *Storks*, there appear to be three types (which might be made into as many sub-genera) among the Indian *Ciconiæ*. One is represented by the *white Stork*, a second by the *black Stork*, and a third by the *carrion eating Storks*, or *Adjutants*. The *white-necked stork* appears to be a link between the *white* and *black Stork*, as well in form as in its habits, being partly terrestrial, and partly aquatic in its habits.

313.—*C. alba*, Briss.—*Lug-lug* or *Oojlee*, H. also *Hajee Lug-lug.*—*White Stork.*

The *white Stork* is found, though rarely, throughout India, during the cold weather only, feeding in large flocks on the open dry plains on grasshoppers, beetles, and other land insects, also on lizards and small snakes.

Irides brown; bill, legs and feet red.

314.—*C. leucocephala.*—*Ard. leucocephala*, Auct.—*Cic. umbellata*, Wagler.—*Kalee*, H.—*Manukjor*, in Hindostan.—*White necked Stork.*

This handsome *Stork* is a permanent resident in India, breeding on high trees in the more wooded parts of the country. In its habits it

partakes somewhat of both the *Cic. alba*, and *Cic. nigra*, being, though perhaps most generally found about rivers, streams, marshes and tanks, often seen feeding on the open dry plains, or on bare cultivated ground. It feeds alike on fish, frogs, crabs and other aquatic food, and on grass-hoppers, beetles, and other land insects.

Irides dark scarlet, surrounded by an external narrow ring of pale yellow; bill black, dark red at the edges and point; naked skin of the face black; legs red. Length 30 to 34 inches; bill at front 6½-7.

315.—*C. nigra*, Auct.—*Soormaee*, H.—*Black Stork.*

This, like the *Oojlee* is also migratory, being only found in the Peninsula during the cold season. It is a rare bird, and generally seen solitary near tanks, rivers, and small streams, feeding on fish, frogs, and various aquatic insects, and their larvæ. A good *Bhyree* will strike it down, and it is eagerly sought after for this purpose.

Orbits naked and red; bill deep red; irides brown; legs brownish red. Length 3½ feet; expansion of wings 6 feet; bill at front 7½ inches; tarsus 8¼.

316.—*C. Argala*, Steph.—*Ard. dubia*, Gmel.—*Cic. Marabou*, Temm. —*Adjutant* of Calcutta.

I have but once seen this enormous bird during the early part of the monsoon in the table land near Jaulnah, but did not obtain it.

317.—*C. nudifrons.*—New species ?.—*Dusta*, H.—*Black-mantled Adjutant.*

Descr.—Plumage above glossy black; the greater coverts pale dusky brown, edged with whitish, beneath pure white. Bill, frontal plate, and occiput, dirty greenish; head, neck and gular bag, reddish pink above, yellowish beneath; head, neck, and as far as the end of the gular bag, covered with strong scattered hairs, or rather hair-like feathers. Irides light greyish brown or grey; feet blackish; forehead, only, naked and horny. Length 4½-5 feet; bill at gape 11½ inches, 2 inches broad beneath at the base; 3 inches high at base; tarsus 11; tibia 15; tail 12; wing about 30; face, throat and lower part of neck with numerous black spots; gular bag when *stretched* about 6 or 7 inches long.

This species is tolerably common in the northern portion of the Dekhan, more especially during the monsoon. It is usually solitary—occasionally in parties of 4 or 5. It descends like the *Vultures* on any carcasses, or stalks about the plains, sometimes close to cantonments, picking up reptiles, insects, and garbage of any description.

318.—*C. calva.*—New species ?—*Chinjara*, H.—*Crab-eating Adjutant.*

Descr.—Above glossy black, with purple and green reflections; the feathers of the back and coverts obsoletely marked with numerous black bars; greater coverts dark brown; tertials and scapulars, bottle green, edged with white; beneath pure white; bill dirty greenish; head perfectly naked and horny. A thick tuft of hairs on the occiput, and a few scattered hairs on the neck. Has no gular pouch. Length 4½ feet; bill 11½ inches; much more slender than in the last. Breadth at base beneath 1½; height at do. 2½; tail nearly 12; tarsus 10; wing 25 inches. I found the stomach of one crammed with crabs, and a few large grasshoppers.

The under tail coverts of the 3 last species are known under the name of *Marabou* feathers, and are highly prized, and much sought after.

Sub Genus MYCTERIA, L.

319.—*M. Australis*, Lath.—*M. Asiatica*, Lath. ?—*Bunarus*, H.—*Large black* and *white Stork.*

This gigantic looking bird is rare in Southern India, being found singly occasionally in tanks and large rivers. It lives on fish, frogs, and various other aquatic animals. Its length of limb gives it the appearance of being a much larger bird than it really is. The young bird has the neck light brown, and very downy, and the colours much less vivid throughout; the irides also dark brown.

Irides yellow; bill black; legs rosy red. Length 4½ feet; expansion about 7 feet; bill 13 inches; tarsus 13½; weight about 11 lbs.

Genus HÆMATOPUS, L.

320.—*H. ostralegus*, L.—*Durya Gujpaon*, H. i. e. *Sea Longshanks* (*Himantopus*).

This bird is included in Mr. Elliot's Catalogue, having been found by him on the western coast, towards the more northern part of the Peninsula, and I have since heard of its having been procured as far to the southward as Mangalore.

Family TANTALIDÆ.—Ibis.

Genus ANASTOMUS.—Ill.—*Open beak.*

321.—*A. typus*, Temm.—*Ard. Coromandelica* and *Ard. Ponticeriana*, Auct.—*Goongloo* or *Goonglah*, H.—*Indian Shell Eater.*

This curious bird is tolerably common in those parts of the country where tanks and marshes abound. It lives in flocks of various size or solitary, and feeds on fish, frogs, and various other aquatic animals, but chiefly when procurable, on shell-fish (a species of *Unio*), the breaking of the shell of which to get at the contents, is the cause of the open space or gape between the mandibles, which does not exist in the young birds. Colonel Sykes I see, however, appears to think that the gape exists originally in the young bird, and that it is a provision of nature to effect the opening of the shells, on which it feeds. From my own observations, however, corroborated moreover by Mr. Elliot's, I am inclined to think that the former is the more correct opinion, viz. that the open space is caused by the constant attrition of the mandibles on the hard testaceous covering of the shell-fish. The *Goongloo* frequently perches on trees, and breeds, I am informed, on lofty trees.

Irides bright yellow; bill dark greenish; orbits and pouch, naked and black; legs greenish, with a shade of pink; middle claw, with a sharp edge internally, but not serrated. Length 32 inches; expansion of wings 4½ feet.

This bird flies tolerably rapidly, and with more quickly repeated strokes of its wings than any of the *Heron* family, with which it has generally been placed by systematists.

Genus TANTALUS, L.

322.—*T. leucocephalus*, Lath.—*T. Indicus*, Cuv.—*Dŏkh*, H.—*Jaunghul*, in Hindostan.—*Pelican Ibis.*

The *Pelican Ibis* (as it may be named) is common over all India, frequenting rivers, tanks, pools and marshes, generally in parties more or less numerous, and feeding on fish, frogs and aquatic insects, and also according to Sykes, on vegetable matter. It perches freely on trees, and breeds on lofty trees, during the hot weather and monsoon. During the heat of the day, they may be seen standing motionless in the water knee-deep, digesting their morning's meal. They are said to feed a good deal, during the night. The scapulars assume their most beautiful rosy tinge, during the hot weather, or breeding season. The *Bhyree* strikes this bird always on the head, its mandibles being sharp, and inflicting a severe cut.

Irides yellowish brown; bill, naked face and crown, and chin pouch, deep ochre or orange yellow; legs pale dirty pink. Length 3½ feet; expansion of wings about 6 feet; bill (at gape) sometimes nearly 1 foot.

Genus IBIS.

323.—*I. Macei*, Cuv. and Wagl.—*I. religiosa*, of Sykes' Cat.—*Tant. melanocephalus* of Lath.—the young bird.—*Moonda*, H.—*Suffeid Boozah* of some.—*Black-headed Ibis.*

The Indian *Black-headed Ibis*, is generally supposed to be a different species from the one found in Egypt, and which was held sacred, and embalmed by the ancient Egyptians. Colonel Sykes, however, asserts their identity. This bird is found in tanks, rivers, marshes, wet paddy-fields, &c. in flocks of various size, and feeds on small fish, frogs, crabs, shrimps, and a variety of insects, both water and land, for it is occasionally seen feeding on the dry ground, near rivers and tanks. It is found at all seasons, and therefore most probably, breeds in this country, though I have not yet seen its nest. Inside the bone of the wings is covered by a bright red skin, as in the *Cic. leucocephala.* The young bird has the head and neck partly covered with small white feathers, and is therefore, as Wagler imagines, the *Tant. melanocephalus* of Latham.

Irides lake red; bill, naked head and neck, and feet black. Length 30 to 34 inches; bill at gape about 7; tarsus 4; weight 3½ lbs.

324.—*I. papillosa*, Temm. P. C.—*Boozah*, H.—*Kala Boozah* of some. —*Warty-headed Ibis.*

This bird is of common occurrence throughout India, being found in numerous flocks, feeding on the open plains, chiefly on grasshoppers, beetles, and other land insects, also few even on water insects, frogs, &c. It breeds on trees in the neighbourhood of water, sometimes alone, but at times in numerous parties. Colonel Sykes says correctly "Soar high in the air, uttering melancholy screams." It makes a long flight with a *Bhyree*, and requires a good one to capture it.

Irides light red; bill brownish red; legs dirty brick red; papilla of the crown and occiput, bright red—naked skin on which they are placed black. Length 25 to 30; bill at gape 6; tarsus 3; weight 3¼lb.

325.—*I. falcinellus*, Temm.—*I. igneus*—young bird of the 2d year, according to Wagler.—*Kewaree*, H.—*Glossy Ibis.*

As I have always shot the so called *I. igneus* in company with the other species, I am induced to agree with those who consider it as the young bird of the *I. falcinellus.*

The *Glossy Ibis* frequents shallow water at the edge of tanks and rivers—also marshes and wet paddy-fields. It is always found in flocks,

and feeds on frogs, shell-fish, shrimps and various insects, and their larvæ, both aquatic and terrestrial.

Irides brown ; bill and legs dark olive green ; a whitish skin goes round the base of the bill, the eyes and the gape. Length varies from 22 to 26 inches ; of a full grown male, the bill is nearly 6 inches ; and tarsus 4½.

Family RALLIDÆ.—Rails, &c.

Genus PARRA, L.—*Peeho*, H.—*Tank-runner.*

326.—*P. Indica*, Lath.—*P. ænea*, Cuv.—*P. melanchloris*, Vieill.—*P. superciliosa*, Horsf.—*Indian Tank-runner.*

This curious bird is found over most of the Peninsula, in tanks covered with weeds, and water lilies, on the leaves of which it runs with great facility. It feeds chiefly on seeds, and other vegetable matter.

Bill green at the base, yellowish at the tip ; legs dark green. Length about 1 foot ; bill to posterior end of frontal plate 1¾ ; tarsus 2$\frac{8}{10}$ths ; centre toe and claw 4½ ; hind do. 4.

327.—*P. Sinensis*, Gmel., Gould. Cent. Him. Birds.—*Golden-necked Tank-runner.*

This handsome species, is perhaps, more generally spread than the last, but not so numerous, except in some few localities. It frequents, like the last, weeded and lily-covered tanks, but is also often to be seen feeding at the edges of rivers and tanks, totally devoid of weeds. Feeds on seeds, also on shells and water bugs.

Irides deep brown ; bill and legs olive green. Length 22 inches ; tail 11½ ; tarsus 2 ; middle toe and claw 3 ; hind do. 2 ; bill at front 1.

Genus PORPHYRIO, Briss.

328.—*P. smaragnotus*, Temm.—*Gall. poliscephala*, Lath.—*Keima*, H. —*Sultana Coot* or *Purple Coot.*

This handsome bird is tolerably common on most of the weedy and grassy tanks, throughout the country, especially when covered with the lotus, walking easily on the leaves, and feeding chiefly on seeds and vegetable matters.

Irides blood red ; bill and frontal plate, cherry red ; legs pale brick

red ; wing spur also reddish. Length 18 inches ; bill at gape $1\frac{1}{2}$; tarsus $3\frac{8}{10}$; middle toe and claw nearly 5 ; hind do. $2\frac{1}{2}$.

Genus FULICA, L.—*Coot.*

329.—*F. atra*, L.—*Dasree* or *Dasurnee*, H.—*Bald Coot.*

The *Common Coot* of Europe is a common and abundant bird on most of the Indian tanks, even on those that dry up during the hot months. Lives chiefly on vegetable matters.

Irides blood red ; bill and frontal plate white ; legs green reddish at the sides ; feet leaden coloured. Length nearly 18 inches.

Genus RALLUS, L.—*Rail.*

330.—*R. Gularis*, Horsf. ?—*R. cærulescens*, Lath. ?—*Blue-throated Rail.*

The species of *Rail*, of which I give a description below, is found in reeds and long grass, by the sides of tanks, rivers and water-courses. I have only seen it in Travancore and Cochin, but it is also enumerated in Mr. Elliot's Catalogue, as found in Dharwar.

Descr.—Crown, top of the head and nape, deep chestnut, diverging into two streaks on the back of neck ; chin white ; cheeks, sides of neck, throat and breast, light leaden ; back, beneath, and wings dark brownish, with a strong olive gloss, and numerous narrow white transverse bars, most numerous on the abdomen and thighs.

Bill sanguineous at the base, and diaphanous, brownish at the tip ; legs brown, with a reddish tinge. Length about 11 inches ; wing $4\frac{8}{10}$; tarsus $1\frac{6}{10}$; bill at front $1\frac{2}{10}$.

331.—*R. rufescens*, Vieill. ?—*R. Philippensis.* ?—*R. striatus.* ?—*R. Ceylonicus.* ?—*Larger brown rail.*

I procured a single specimen of a *Rail* near Cochin, which I cannot refer exactly to any described species, but which appears to approach some of the species named above. I add a brief description : head deep brown ; above olive brown ; the feather edged with pale yellowish rufous ; cheeks and sides of neck fawn ; chin and throat white ; beneath pale fawn, with numerous transverse dark marks ; middle of abdomen white ; shoulder with a tinge of cinereous and edged white. Length 14 inches ; wing 7 ; tarsus $2\frac{1}{2}$; tail 3 ; bill at the front, including frontal plate $1\frac{1}{2}$.

Genus GALLINULA.

332.—*G. akool*, Sykes.—*Indian Water Hen.*

This common bird is found chiefly in reeds and long grass, by the sides of tanks, rivers, and water-courses, and is flushed with difficulty.

I have seen specimens exactly like those described by Sykes, others in which the chin was entirely black,—and others in which there was much white, extending down the middle of the abdomen. These were all from different localities, but most probably, were only different ages of the same bird. There may, however, be several varieties, or it may be distinct species. Length nearly 1 foot; bill at gape 1 inch; tarsus $1\frac{7}{10}$; middle toe and claw nearly 3; hind do. $1\frac{2}{10}$.

333.—*G. Javanica*, Horsf., most probably the same as the *G. phœnicura.*—*Dawuk*, H.—*White-cheeked Gallinule.*

This handsome bird is by no means uncommon in many parts of the country, though seldom seen in some districts. It frequents bushes in the neighbourhood of water or marshy spots—also gardens and hedges in dry ground. Found both solitary, and in parties of 5 and 6. Feeds upon insects of various kinds, both land and water.

Irides red; bill green, whitish at the tip; legs greenish yellow; dusky behind. Length 12 inches; bill at gape $1\frac{1}{2}$; tarsus $2\frac{2}{10}$ths; middle toe and claw $2\frac{3}{4}$; hind do. $1\frac{2}{10}$ths.

Family SCOLOPACIDÆ.—*Snipes and Sand-pipers.*

Genus SCOLOPAX, L.

Sub Genus RHYNCHÆA.—Cuv.

334.—*R. picta*, Gray, Proc. Zool. Soc.—*R. capensis*, Auct.—*Painted Snipe* of Europeans in India.

The *Painted Snipe* is a permanent resident in India, being found at all seasons in suitable ground, viz. the grassy edges of tanks, marshes, inundated paddy-fields, and the usual haunts of the common snipes. It, however, appears in much greater numbers at the commencement of the cold season, along with the other snipes, so probably the greater number breed towards the more northern part of India. This has, probably,

led Colonel Sykes and others to consider it as migratory. I have, however, seen it throughout the hot weather and monsoon in two successive years, and find the same fact stated by Mr. Elliot.

Irides dark brown; bill dusky reddish; legs green. Length about 9 inches; bill 2; tarsus $1\frac{8}{10}$ths.

Sub Genus SCOLOPAX.

335.—*S. rusticola ?—S. minor ?—S. saturata*, Horsf. ?—*Neilgherry Woodcock.*

I find it impossible from the meagre descriptions of authors, to ascertain whether this bird is identical with the European bird or not, or whether, as some have supposed, it may be the American species, from its smaller size. It appears to correspond in plumage pretty closely with the European bird, but from the examination of a good number of fresh specimens, it seems to be a considerably lighter bird. It arrives on the hills about November; a stray bird or two being sometimes killed in October, and leaves in March.

Length 15 to 16 inches; wing $8\frac{1}{4}$; bill at front 3 to $3\frac{2}{10}$ths; tarsus $1\frac{8}{10}$ths; tail $3\frac{1}{4}$; average weight about 9 or $9\frac{1}{2}$ oz.; varies from 7 to 11 oz.

336.—*S. nemoricola,* Hodgson, Journ. Asia. Soc. No. 66.—*Solitary Snipe* of the Neilgherries.

This bird differs considerably from the solitary snipe of Europe (*S. major*, L.). It is a rare visitant to the Neilgherries during the cold season, and has not, as far as I am aware, been killed elsewhere in the Peninsula. It frequents the marshy ground at the foot of the dense woods of the hills. I obtained a specimen from J. Scott, Esq. of the M. C. S. which is about 13 inches long, the bill being 2 $\frac{6}{10}$ths.

337.—*S. gallinago*, L.—*Bhuruk* or *Buruk*, H.—*Common Snipe.*

The *Snipe* is found in great numbers all over the Peninsula during the cold season, frequenting grass by the sides of tanks, and streams, marshes, but more especially the inundated paddy-fields.

338.—*S. gallinula*, L.—*Jack Snipe.*

The *Little Jack Snipe* is tolerably abundant along with the last in some parts of the country, especially towards the more northern part of the Peninsula.

Sub Genus LIMOSA, Briss. and Swains.—*Godwit.*

339.—*L. leucophœa ? ?.*—New species ?—*Chaha*, H.—*Large Godwit.*

This bird, which, in absence of more precise information, I have referred to the European *Godwit*, though strongly suspecting it to be distinct, is a rare visitant to the Peninsula, during the cold weather, and frequents the shallow water at the edge of large tanks. I add a brief description.

Above ashen grey, darkest on the back and rump; beneath white, ashy on the neck, breast and sides; upper tail coverts white, black tipt; tail white at the base, the rest black, with a narrow black tip. Length 20-21 inches; bill 5; tarsus 4; wing 9; tail $3\frac{1}{4}$; bill reddish white, dusky at the tip; legs and feet greenish black.

340.—*L. melanura ?.*—*Chota Chaha*, H.—*Lesser Godwit.*

I have only seen this species on two or three occasions, at the edges of tanks, on the northern part of the table land. As I am by no means certain, that it is the same as the European bird, I also add a description of this one. Plumage above brown; the feathers edged with fawn; head, neck and breast, pale ashy brown; throat white; tail black, white at the base; tail coverts as in the last. Length of one specimen 17 inches; bill 3 $\frac{4}{10}$ths; tarsus $2\frac{1}{2}$; wing 8; tail $2\frac{3}{4}$.

341.—*L. terek*, Horsf.—*S. terek*, Lath.—*Limicola Indiana*, Vieill.

I have only seen this curious bird on one occasion at the edge of the Trichoor lake. Length nearly 9 inches; bill 1 $\frac{8}{10}$; wing 5; tail 2; tarsus $1\frac{1}{10}$ths; bill blackish, green at the base; legs orange.

Sub Genus TRINGA, L. Swains.

342.—*T. Hardwickii.*—*Limosa Hardwickii*, Gray and Hardw. Ill. Ind. Zool.—*Gehwala*, H.—*Large brown Sand-piper.*

I can find no description of this handsomely plumaged *Sand-piper* in any of the works I possess. It appears, however, to be the same as the species figured in Gray and Hardwicke. It is one of the first that make their appearance here, at the commencement of the cold weather. I have seen them in the middle of September, and as late as the end of March. It frequents the edges of large tanks in numerous flocks. I add here a brief description. Plumage above brown, of various shades of intensity, each of the feathers edged with pale brown, or whitish, or in some with rufous fawn; head and neck paler; face, throat, and plumage beneath white, ashy on the neck and breast. In those specimens killed

earliest in the season, the colour of the back is most intense brown, and the feathers are broadly edged with rufous. The neck and head too are tinctured with rufous; tail ashy pale brown, some of the centre feathers barred at the tip with black and white.

Length 12-13 inches; bill 1 $\frac{3}{10}$; tail $2\frac{1}{2}$; wing $7\frac{1}{4}$; tarsus 2 ; legs fleshy, ochrey colour; weight about $6\frac{1}{4}$ ounces.

343.—*T. Indica.*—*Tot. Indicus*, Gray and Hardw., Ill. Ind. Zool. ? ?

This very closely resembles the last, and indeed only differs in size, weighing little more than half of the last. As, however, I have found it of the same size throughout all the cold weather, and the species of *Sand-piper* in general are very uniform in size, I have ventured to place it as a distinct species.

Length $9\frac{1}{2}$-$10\frac{1}{2}$; wing 6; tail 2 $\frac{2}{10}$; bill 1 $\frac{2}{10}$; tarsus 1 $\frac{6}{10}$; weight about $3\frac{1}{2}$ to 4 ounces.

344.—*T. subarcuata ?*

I have only seen this *Tringa* once or twice, frequenting the sides of tanks in the northern part of the Peninsula.

Length about 8 inches; wing 4 $\frac{6}{10}$; tail 2; tarsus rather more than 1; bill deep black; legs greenish brown.

345.—*T. pusilla ?*—*Chota pun-loha*, H.

I have found this bird all over India, frequenting rivers, sides of tanks, and inundated paddy-fields, in numerous flocks.

Bills and legs black; irides dark brown. Length 6 inches; wing 3 $\frac{8}{10}$ths, a little longer than the tail, which is somewhat above $1\frac{1}{2}$; bill at front $\frac{7}{10}$ths; tarsus $\frac{9}{10}$ths.

346.—*T. Temminckii*, Leister ?

Not nearly so common, I think, as the last species, to which it is closely allied, and has the same habits.

Bill greenish at the base, black at the tip; legs green, with a tinge of reddish. Length $6\frac{1}{4}$; wing 3 $\frac{8}{10}$; tail nearly 2; bill $\frac{7}{10}$; tarsus $\frac{7\frac{1}{2}}{10}$ths.

Genus HIMANTOPUS, Briss. and Swains.

Sub Genus RECURVIROSTRA, L. *Avoset.*

347.—*R. Avocetta.*—European *Avoset.*

I have only seen this curious bird at the edge of a large tank at the extreme north of the Peninsula, but I have seen stuffed specimens killed as far south as Madras.

Irides red brown; bill black; legs French grey. Length 18 inches; bill 3 $\frac{3}{10}$; tarsus 3¼.

Sub Genus HIMANTOPUS.—*Longshanks.*

348.—*H. melanopterus*, Auct.—*Guj-paong*, H.—*Common Longshanks* or *Stilts.*

Very common all over India, during the cold weather, not leaving till April, frequents rivers, tanks and marshes in numerous flocks. A few couple probably remain here the whole season, as I have seen them as late as June, in pairs on the banks of wooded streams and reedy tanks.

Sub Genus TOTANUS, Sw.—*Sand-piper.*

349.—*T. glottoides*, Vigors, Gould's Century of Himalayan Birds.—*Timtimma* or *Toomtomma*, H.—*Indian Greenshanks.*

Found solitary all over India in rivers, brooks and tanks. Is a wary bird, rising with a very shrill and loud cry—hence its Indian name.

Irides dark brown; bill greenish black; legs pale olive. Length 14; bill 2$\frac{2}{10}$ths; wing 7; tarsus 2½; middle toe 1$\frac{6}{10}$ths.

350.—*T. Horsfieldii.*—*Limosa Horsfieldii*, Sykes.—*Chota Timtimma* H.—*Lesser Greenshanks.*

This, like the last, is in general found solitary, but much more rare. I have, however, seen it in very large flocks at the Trichoor lake.

Irides dark brown; bill blackish; legs pale olive green. Length 10 inches or 10½; wing 5½; tail 2½; tarsus 2$\frac{3}{10}$ths; bill to front 1$\frac{6}{10}$ths; weight 3 ounces.

351.—*T. fuscus?*—*Butan*, H.—*Large red-legged Sand-piper.*

Whether this is the species to which I have temporarily referred it or not, can only be determined by actual comparison. I have found this bird very rarely in the Peninsula of India, and only towards the more northern portion of it, by the side of rivers or tanks, and solitary. Specimens killed towards the end of the cold season in April, had assumed the dark summer plumage.

Irides dark brown; bill brown, red at the base beneath; legs orange red. Length 14 inches; wing $6\frac{1}{2}$; tail $2\frac{1}{2}$; bill $2\frac{3}{10}$ths; tarsus $2\frac{3}{10}$ths.

352.—*T. calidris*, Auct.?—*Chota Butan*, H.—*Redshanks.*

As the bird I am now speaking of, is about the same length, and answers nearly to the description of the European *Redshanks*, I have for the present referred it to that bird. I have only obtained a single specimen of this *Sand-piper*, shot at the edge of a tank in the northern part of the table land.

Irides dark brown; bill brown; legs orange red. Length $10\frac{1}{2}$-11 inches; wing 6; tail $2\frac{4}{10}$ths; bill $1\frac{6}{10}$ths; tarsus $1\frac{8}{10}$ths.

353.—*T. glareola*, L.

Found in small parties, or sometimes solitary at the edges of tanks, rivers, brooks and pools of water, common every where. Length 9 inches.

354.—*T. Ochropus.*

Almost always found solitary, occasionally in parties of 3 or 4, in the same localities as the last, and still more common.

Length 10 inches.

355.—*Hypoleucos.*

Found solitary in similar situations with the 2 last species, but not nearly so common.

Length 8 to $8\frac{1}{2}$ inches; wing $4\frac{1}{2}$; tail $2\frac{2}{10}$ths; tarsus 1; bill nearly 1; bill brown, greenish at base beneath; tarsus pale green.

Genus STREPSILAS, Ill.—*Turnstone.*

356.—*S. interpres*, Auct.—*Common Turnstone.*

I obtained a pair of these prettily marked birds at the tank of Jaulnah, 200 miles inland, in the month of April, and have since seen specimens procured as far to the southward as Madras.

Irides dark brown; bill black; legs orange. Length 9 inches; wing 6; tail $2\frac{1}{2}$; tarsus nearly 1 inch; bill at front $\frac{9}{10}$ths.

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Genus NUMENIUS, Briss.—*Curlew.*

357.—*N. arquata.*—*Goungh*, H.—*Curlew.*

I obtained a single specimen of the *Curlew* at the edge of a tank, near

Jaulnah. It is enumerated also in Mr. Elliot's Catalogue as found in Dharwar.

358. *N. phæopus.—Chota Goungh*, H.—The *Whimbrel.*

I saw the *Whimbrel* in considerable numbers at the Chilka lake, and have also seen it on the sea coast, near Madras, and in various other places. Mr. Elliot says, 'Found every where along the sea-shore, and mouths of large rivers.'

Family CHARADRIADÆ.—*Plovers.*

Genus CHARADRIUS, L.

359.—*C. pluvialis*, L.—*Golden Plover.*

The *Golden Plover* is but rarely met with in the Peninsula. I have only seen it on two or three occasions on the banks of large rivers on the table land, and on grass plains, near the sea coast—usually in small flocks of 5 or 6. I have seen specimens killed in the neighbourhood of Madras, in the breeding plumage viz. with the whole under surface of the body deep black. It therefore, most probably, breeds in this country.

360.—*C. Philippensis*, Lath. ?—*Zirreah*, H. of some.—*Common ringed Plover.*

This pretty little bird is found not only at the sides of rivers, and tanks, but also, and perhaps more generally, in the open dry plains, in flocks of various size, running rapidly along the ground, and picking up various small insects. I have found it all over the Peninsula.

Irides deep brown ; bill black ; legs yellowish ; orbits bright yellow. Length $7\frac{1}{4}$; wing $4\frac{3}{4}$; tail $2\frac{1}{2}$; bill at front $\frac{1}{2}$ inch ; tarsus nearly 1.

361.—*C. minor*, Wagl. ?—*C. hiaticuloides*, Frankl?.—*Lesser ringed Plover*

This species differs but little from the last. It is smaller—has the upper plumage of a darker shade, the quills also much darker, the tertials less lengthened, the lateral tail feather have more white, and the base of the lower mandible is yellow.

I have only found it at the northern part of the table land, at the edge of rivers.

Irides deep brown ; bill black, yellow at the base beneath ; legs yellow ; orbits deep yellow. Length hardly $6\frac{1}{2}$; wing 4 ; tail 2 ; bill to front $\frac{4}{10}$; tarsus $\frac{9}{10}$ths.

362.—*C. cantianus.* ?—*C. ruficapillus*, Temm. ?—New species.?

I have found this *plover* at the edge of rivers and tanks, at the northern part of the table land, and also more lately by the side of salt-water inlets, and the sea shore on the east coast, during the hot season in June.

As I am uncertain of its being the European species indicated, I shall give a brief description.

Forehead, eyebrows, face and beneath, pure white ; a narrow line from the gape, passing through the eyes and ears, cinereous; a narrow blackish band behind the white forehead ; crown of head and nape ferrugineous ; plumage above cinereous ; external tail feathers pure white ; no naked skin round eyes ; bill black ; legs greenish yellow.

Length 7 inches ; wing 4 $\frac{3}{10}$; tail 1 $\frac{8}{10}$; bill at front $\frac{6}{10}$; tarsus rather more than 1 inch.

363.—*C. russatus.*—New species. ?

Descr. Forehead, streak on either side, extending through the eyes, ears, and meeting behind, and a broad pectoral band deep brownish black ; top of the head, back and wing coverts of the usual brown cinereous hue of the *Ringed Plovers* ; band above the eyes, encircling the head, except in front, and plumage beneath white ; wing coverts edged with white ; quills and medial tail feathers, dark brown ; external tail feathers white, with a brown band which almost disappears on the outermost feather ; scapulars deep marroon colour ; upper tail coverts, tinged with rufous ; bill yellow with black tip ; orbits bright yellow ; legs orange yellow.

Length 6½ inches ; wing 4½ ; tail 2 $\frac{2}{10}$; bill at front nearly $\frac{6}{10}$ths ; tarsus rather more than 1 inch.

I procured a single specimen of this apparently new species of *Ringed Plover* at the edge of the Pulicat lake near Madras, in the month of June. Its distinguishing feature is the marroon colour of the scapulars. Whether this is a permanent mark, or, as I conjecture may be the case, only assumed during the breeding season, I am at present unable to determine.

GENUS VANELLUS.—*Lapwing.*

364.—*V. bilobus.*—*Charadrius bilobus*, Gmel. and Wagler.—*Zirdee*, H.—*Yellow wattled Lapwing.*

This *Plover* is found throughout India, usually frequenting the dry stony plains, or open sandy downs in small flocks, and feeding on various insects. Has a feeble cry, which Colonel Sykes renders as "*Deewit Deewit.*" I found the eggs of this bird on one occasion on a grass plain, on the west coast, in the month of September. They were of a light salmon colour with dusky spots, 4 in number, and laid on a slight depression of the ground.

Irides silvery grey; bill black, yellow at the base; naked skin yellow; legs do. Length nearly 12 inches; wing $8\frac{1}{4}$; tail $3\frac{2}{10}$; tarsus $2\frac{4}{10}$; bill to front 1 inch.

365.—*V. Goensis.*—*Tringa Goensis*, Lath.—*Char. atrogularis*, Wagler.—*Teteehree* (vulgo *Teetooree*), H.—*Red wattled Lapwing.*

This well known bird is common throughout most of India, single occasionally, but usually in small parties. It frequents the land in the neighbourhood of water, feeding on various insects, chiefly water ones, shells, &c. It has a loud shrill cry, something like '*Did he do it,*' or as others say '*Pity to do it.*' This call is much heard at night, even in places where none were seen during the day. It is often very annoying to sportsmen, hovering over him, and uttering its shrill cries for some distance.

The *Teteehree* is said by the natives to sleep with its legs upwards, and the Indian proverb '*Teteehree se asman thama jaega,*' or can the *Teteehree* support the Heavens? is applied to a person who undertakes something far above his strength.

Irides red; bill at the base and fleshy skin, lake red; tip of bill black; legs yellow. Length nearly 13 inches.

366.—*V. ventralis.*—*Charad. ventralis*, Gray and Hardw., Ill. Ind. Zool.—*C. coronatus*, Vieill.?

I obtained a single specimen of a bird which appears to be the young or female of the one figured in Gray and Hardwicke, at the edge of a large tank near Jaulnah. It answers the description too (with the exception of the black spot on the abdomen) of *Wagler's C. ventralis*, but that bird is described among the 3-toed *Charadrii.* My bird has a hinder toe, though a very small one.

This bird is evidently a link joining the *Vanelli* to the *Œdicnemi*, its bill being larger and more robust than that of most *Vanelli.*

Irides dark brown; bill and legs black. Length 13 inches; wing $8\frac{1}{2}$; tail $3\frac{1}{2}$; tarsus $2\frac{3}{10}$; bill to front $1\frac{2}{10}$ths.

Genus ŒDICNEMUS, Cuv.

367.—*Œ. crepitans*, Temm.—*Char. Œdicnemus*, L.—*Burseree* or *Kurwanuk*, H.—also sometimes *Lumbee.*—*Bastard Florikin* of English.

The *Thick-kneed-plover* of Europe is found all over the Peninsula, and remains the whole year. It frequents the open stony plains—also bushy tracts, and open spaces in jungly districts. Found in pairs, or in small parties. When approached, it often conceals itself behind a bush or stone, and sometimes squats close to the ground, and is with difficulty seen. It feeds on various insects chiefly, also sometimes on seeds of various kinds. It wanders much at night, and has a peculiar long shrill piping note ; seldom heard except at this time—its usual cry, being a single harsh creaking note. The *Shikra* (*Accipiter Dukhunensis*) is often flown at this bird. Its flesh is of excellent flavour, and much esteemed by some.

Irides pale greenish yellow; legs pale olive. Length 16-17 inches; wing 9 ; tail $4\frac{1}{2}$; tarsus $3\frac{4}{10}$; bill at front $1\frac{1}{2}$; weight about 12 to 13 oz.

368.—*Œ. recurvirostris*, Swains., Lardn. Cycl.—*Aubee*, H.

This curious bird which has been lately accurately described by Swainson, is by no means common, and is only found by the sides of the larger rivers, and tanks, and salt-water inlets, in pairs, sometimes two or three pairs together. It feeds on various aquatic insects and their larvæ. Its cry of alarm is a loud harsh creaking note, and like the last species, it occasionally squats, when approached.

Irides pale yellow ; bill black, yellow at base ; legs yellowish green. Length 20 inches ; wing 11 ; tail $4\frac{1}{2}$; bill to front $2\frac{6}{10}$ths ; tarsus $3\frac{1}{4}$.

Genus TACHYDROMUS, Ill.

Sub Genus GLAREOLA, L.—*Swallow Plover.*

369.—*G. Orientalis*, Leach.—*Lesser* or *square-tailed Swallow Plover.*

This neatly plumaged little bird is rare in most parts of Southern India. I have seen it occasionally in pairs, by the sides of tanks, running briskly along the edge, and picking up various small insects. I on one occasion saw a large flock of them, apparently migrating from one district to another, it was in the month of September, and near the extreme south of the Peninsula.

Irides dark brown; bill black; gape dark red; legs black. Length $7\frac{1}{4}$ inches; wing beyond tail $1\frac{6}{10}$ths; from base 6; bill at front $\frac{4}{10}$ths; tarsus $\frac{9}{10}$ths.

370.—*G. torquata*, Temm.—*Fork-tailed Swallow Plover.*

I have seen this bird but very rarely in small flocks, or pairs, by the edges of tanks or rivers, feeding chiefly like the last, on various aquatic insects and larvæ, especially on *Nepæ*. On one occasion, I saw a numerous flock of them flying low over some grain fields, apparently capturing insects on the wing. Its flight is remarkably swift, and swallow-like, as is that of the last species.

Irides dark brown; bill and legs black; the posterior portion of the gape red. Length 11 inches, of which the tail is $4\frac{3}{4}$; wing $7\frac{1}{2}$; bill at front $\frac{1}{2}$ inch; at gape nearly 1 inch; tarsus 1 $\frac{3}{10}$ths.

Sub Genus TACHYDROMUS, Ill.—Cursorius, Lath.—*Courier Plover.*

371.—*T. Asiaticus.*—*Char. Coromandelicus*, L.—*Nookree*, H.—*Indian Courier Plover.*

The *Courier* is very numerous towards the more northern part of the table land, much less so towards the south. It frequents the open bare plains only, in numerous flocks, running along with great celerity, and picking up various insects, beetles and small grasshoppers and their larvæ. It breeds in the more retired spot during the hot weather, laying 3 eggs of a pale greenish yellow colour, much blotched, and spotted with black, and also with a few olive spots. They are deposited in a slight hollow.

Irides deep brown; bill black; legs creamy white, as if coated with paint. Length varies from $8\frac{1}{2}$ to nearly 10 inches; wing 6; tail $2\frac{3}{10}$; bill at front $\frac{8}{10}$; tarsus $2\frac{2}{10}$. As I have frequently killed birds of various length from the same flock, I fancy that Swainson's supposed new species *T. Orientalis*, said to differ only in size from the *T. Asiaticus* of authors, must be abandoned.

Sub Genus AMMOPTILA, Sw.

372.—*A. charadroides*, Sw. ?—*Sand Plover.*

A bird of this remarkable genus is mentioned in Mr. Elliot's Catalogue, but without any description, so I am uncertain if it is the same species as

the one indicated by Swainson, in his Synopsis. Mr. E. mentions his having found it in flocks on the sea-shore, on the west coast of India.

Bill black ; legs and feet plumbeous. Length 15 inches.

Ord. NATATORES.—*Swimmers.*

Family ANATIDÆ.—*Ducks.*

Sub Family PHÆNICOPTINÆ,—Sw.

Genus PHÆNICOPTERUS.—L.

373.—*P. Europæus.*—*P. ruber*, L.—*Bug Huns*, H.—*Rajah Huns* of some.—*Flamingo.*

The *Flamingo* is found throughout the Peninsula, in large rivers and tanks, though not a very common bird. I saw it in the greatest abundance in the large Chilka lake, on the low flat islands of which I have seen many hundreds congregated together. It feeds on vegetable matter, and minute water insects, &c. and much gravel is in general found in its stomach. It is tamed, and kept at Hydrabad by some of the nobles of that city, and fed on grain of various kinds. I think Swainson is perfectly justified in placing this bird among the ducks, from its external structure alone, and I see that its internal anatomy fully confirms this view. In fact the natives of India recognize its alliance with this family, by calling it *Heron Goose* or *King Goose.*

Bill pink, black at the tip ; legs pale rose coloured ; irides pale golden yellow. Length 3½ to 4 feet.

374.—*P. minor.*—*Lesser Flamingo.*

I have seen a flock of this bird at the Jaulnah tank, last cold season, and am informed by Shikarees, that it pays an annual visit here, about Christmas.

Sub Family ANSERINÆ.

Genus ANSER, *Antiq.*

375.—*A. Indicus*, Lath., Gould Cent. Him. Birds.—Indian or *Barred-headed Goose.*

This *Goose* is not so common in Southern India, as it appears to be in Bengal, and the more northern Provinces. I have seen it in pairs in August, within a few miles of Cape Comorin, and once or twice in flocks of 15 or 20 in large tanks, on the central table land.

Genus DENDROCYGNA, Sw.—*Tree Ducks.*

376.—*D. Awsuree.*—*Mareca Awsuree*, Sykes' Cat.—*Anas arcuata*, Horsf. Java.—*Sillee*, H.—*Whistling Teal* of Europeans.

As my specimens agree exactly with the description of Sykes, of his *M. Awsuree*, and also the description in Mr. Elliot's Catalogue, I think it may be considered distinct from the Javanese bird. It is found in numerous flocks, in various parts of the country, most abundant, perhaps, in the wooded districts, frequenting tanks, and often seen perched on the boughs of trees that overhang the water. I have not seen its breeding places.

Length about 18 inches; bill to front $1\frac{1}{2}$; tarsus 1 $\frac{6}{10}$; centre toe and claw $2\frac{3}{4}$; wing 8; tail $2\frac{1}{2}$; bill and legs plumbeous; irides brown; eyelids, bright yellow. It is not esteemed good eating.

377.—*D. major.*—New species ?—*Large Whistling Teal.*

I am strongly inclined to consider this as a distinct species from the last. It differs in its larger size, in the whole head, neck and under parts, being rufous or chestnut, and not so dark in the belly as the former bird. The upper tail coverts are yellowish white, instead of deep chestnut. There is a blackish line down the back of the neck from the nape. The tip of the head is deep chestnut instead of brown, and there is a broad patch round the centre of the neck, in which the feathers are somewhat hackled or lanceolate, whitish at the tip, and blackish at the base. The feathers of the loins are highly elongated, chestnut on one side of the shaft, and creamy white on the other side, broadly edged with dusky.

Length 20-21 inches; wing $9\frac{1}{4}$; tail 2 $\frac{1}{4}$ inches; tarsus 2; bill at front $1\frac{8}{10}$ths; centre toe and claw $3\frac{1}{2}$.

378.—*D. ? girra.*—*Anas girra*, Gray and Hardw., Ill. Ind. Zool.—*A. Coromandelica.*—*Geerjah*, H.—*Cotton Teal* of Europeans in India.

This pretty little bird is not very common in Southern India, and like the last, abounds most in the more wooded districts, and it is said to breed in some of the forests of the western coast. It has a peculiar

changing note, not unlike that of the *Grouse*, which it generally keeps up whilst flying. It is found both in pairs and flocks—sexes alike.

Irides bright crimson; bill black; legs greenish ochrey yellow, blackish in some. Length 13 inches; weight 9 ounces.

This bird, by its bill, appears to approach the *Dendronessæ* of Swainson.

378. bis.—*D. affinis.*—New species ?—*Girree*, H.

This species or variety, is mentioned in Mr. Elliot's notes as differing from the last in the permanent want of the collar in both sexes and at all ages.

Length nearly 14 inches.

Genus PLECTROPTERUS, Leach.

379.—*Pl. melanotos*, Steph.—*Anas Melanotos*, Gmel.—*Nooktah*, H. also of the Mahrattahs.—*Bronze-backed Goose*—*Comb-Duck*, (Sykes) of the Residents in the Madras Presidency.

This splendid bird is found all over India, in tanks and rivers, though not very abundant. It breeds during the monsoon in most of the wooded districts, and as I am informed, in long grass, near rivers or tanks. The female is much less than the male, and wants the large protuberance at the base of the bill. It feeds on various seeds and vegetable matters—also on paddy, jowaree, and other grains. The flesh is hard, and not held in much esteem. Length of male 34 inches; wing 16; tarsus 3; bill straight to gape $2\frac{3}{4}$: height of protuberance above 2 inches, from the edge of the mandible, length of do. at the centre nearly 2. Female from 26 to 28 inches long.

Irides dark brown; bill and protuberance black; legs greenish plumbeous; weight nearly 6-lb.

Sub Family ANATINÆ, Sw.—*River Ducks.*

Genus MARECA, Leach.—*Widgeon.*

380.—*M. fistularis*, Steph.—*Anas Penelope*, L.—*Common Widgeon.*

Common in the cold weather throughout India in the rivers and tanks, found in large flocks.

Irides dark brown; bill light plumbeous, black at the tip.

Genus ANAS, L.

Sub Genus CHAULIODUS, Sw.

381.—*C. strepera*, Sw.—*Anas strepera*, L.—The *Gadwall.*

Not so numerous as the last, but by no means rare—only found in the cold season.

Irides brown ; bill blackish, reddish at the sides and lower mandible ; legs and feet ochrey yellow.

Sub Genus ANAS.

382.—*A. clypeata*, L.—*Tredaree*, H.—*Shoveler.*

Common over all India, in flocks during the cold weather.

Irides yellow ; bill black ; legs orange ; bill of female brown, reddish beneath.

Sub Genus BOSCHAS, Sw.

383.—*B. circia.*—*A. circia*, L.—*Garganey Teal.*

Common throughout the cold weather, being one of the first to arrive in the country, sometimes before the end of September.

Irides brown ; bill black ; legs greenish plumbeous.

384.—*B. crecca*, Sw.—*A. crecca*, L.—*Common Teal.*

Common along with the last.

Sub Genus DAFILA, Leach.

385.—*D. caudacuta.*

Tolerably abundant towards the more northern parts of the Peninsula, rare in the south, found in large flocks.

Bill plumbeous, with a black line down the centre, also at edges ; legs plumbeous.

Irides dark brown.

Genus TADOMA, Leach.

386.—*T. rutila*, Steph.—*A. casarca*, L.—*Soorkhab*, H.—also *Chukwa.* —*Ruddy Shieldrake.*—*Brahminy Duck* of Europeans.

This large duck is, like the last one, less common towards the south, than in the more northern parts of the Peninsula. Is frequently seen in pairs, or small parties of 4, 5 or 6, but occasionally, as in the Chilka lake, in numerous flocks of some hundreds. Only found, as far as I can learn, in the Peninsula, during the cold weather. Colonel Sykes, however, appears to think that they are resident in India, throughout the whole year. Found much on rivers. Mr. Elliot in his notes says " Found in pairs, often several pairs together, shy, uttering a peculiar deep note which has a strong resemblance to deeply intonated *ā-oung*." The Hindoos consider them the models of conjugal tenderness. The flesh is held in no esteem in this country.

Irides dark brown; bill and legs black.

387.—*T. ? pœcilorhyncha.*—*A. pœcilorhyncha*, Gmel.—*Gurm-pace*, H. *Spotted-billed Duck.*—*Large Grey Duck.*

This fine duck is most common in the more wooded parts of the country, and is a permanent resident, breeding in retired places and marshy spots, among the jungles, during the hot weather.

Irides brown; bill black, yellow at the tip, red at the base; legs deep red. Length 2 feet to 26 inches; tarsus $2\frac{1}{4}$; weight about 3-lbs. Is excellent eating. I am by no means certain, that it is a true *Tadomer*, being perhaps a species of *Boschas*, or *Chauliodus*; but the elevation of the bill at the base, has induced me to consider it as a *Tadomer*. I on one occasion found a couple of small fish in the gizzard of this *Duck*, besides vegetable matter and gravel.

368.—*T. ? cayophyllacea.*—*Pink-headed Duck*, Lath.

Though I have not yet seen this *Duck*, I venture to include it in my present Catalogue, from the concurrent testimony of several Shikarees, who described it, so as to leave no doubt in my mind of its being the species named as above. It is said to be an occasional, though very rare visitor to the rivers and tanks of the country, about Jaulnah, during the cold weather only.

Sub Family FULIGULINÆ, Sw.

Genus FULIGULA.

389.—*F. rufina*, Stephens.—*Red-headed Pochard.*

Not very common in the Peninsula, generally in small parties in the cold weather.

Irides deep yellow.

390.—*F. cristata*, Steph.—*A. fuligula*, L.—*Tufted Duck.*

Tolerably common throughout the Peninsula, during the cold weather. It is one of the latest to quit the country, and I have on one occasion found a single one in the month of June, in a tank near Hydrabad.

Irides bright yellow; bill plumbeous; legs blackish. Length 19-20 inches.

391.—*F. nyroca.*—*A. leucophthalmos.*—*Bechstein.*

Rare in the Peninsula, generally in pairs, or very small parties in tanks. Irides greyish white. These 3 last species dive remarkably well.

Family COLYENBIDÆ.—*Grebes.*

Genus PODICEPS, Lath.

392.—*P. Philippensis*, Steph.—*Choorakah*, H. ?—*Indian bay-necked Grebe.*

Common in the tanks all over India, even in those which dry up early in the season. Feed on various water insects, &c.

Irides ochrey yellow. Length 9½ inches.

392, *bis.*—*P.* ——— ?—*Lesser Grebe.*—*Pun-doobee*, H. ?

I have hitherto not procured this little species of *Diver*, which is mentioned in Mr. Elliot's Catalogue, though without any description, but I have seen it on several occasions, in grassy tanks, and among weeds. It appears much smaller than the common one.

Family PELECANIDÆ.

Genus PLOTUS, L.—*Darter.*

393.—*P. melanogaster*, Gmel.—*Banwah*, H.—*Darter* or *Snake bird.*

Not very uncommon in the Northern Circars, and in other districts where tanks abound. Feeds on fish chiefly, swims and dives with great rapidity, and as Colonel Sykes remarks, has the faculty of being enabled to swim with the whole of its body under water, the long head and neck being alone visible, looking like a snake.

Length about 3 feet; tail 9½; bill front $3\frac{3}{10}$ths.

Genus CARBO, Mayer and Swains.—*Cormorant.*

394.—*C. Javanicus*, Horsf.—*Phal. Africanus* ?—*Joghrabee*, H.—vulgo *Pun-kowa*—i. e. *Water crow.*

Very common in all the tanks and rivers of India. Feeds on fish, and is very voracious.

Irides crimson ; bill black, reddish at base beneath ; legs black.

I may state that I have specimens, shot in company with many others of the same plumage, which have the wing coverts and scapulars blue grey, margined with black, and in the belly and neck, having much white in their plumage, mixed with dusky blackish.

Length 23 ; tail 6 inches ; bill at front 1 $\frac{1}{10}$th.

395.—*C. Cormoranus.*—*Pelicanus Carbo*, L.—*Gho-ghur*, H.

This is much more rare than the last. I have only seen it on the wooded Bhowany river, at the foot of the Neilgherries, and once or twice in the northern part of the table land, in large tanks. I have seen it in the month of June, as far inland as Hydrabad, so it most probably remains here the whole year and breeds. Mr. Elliot mentions it in his Catalogue, and I learn from him that it is far from being uncommon in parts of the Southern Mahratta Country, and that it may sometimes be seen in considerable numbers, sitting on trees in the neighbourhood of tanks.

Length 2 feet 10 inches ; bill at front 2¼ ; weight 4½ lbs.

Genus PELICANUS, L.

396.—*P. onocrotalus*, L.—*Hawaseel*, H.—The *Pelican.*

The *Pelican* is tolerably common in many of the tanks all over the country, even very far inland, occasionally perches on lofty trees.

Sub Family LARIDÆ.—*Gulls* and *Terns.*

Genus STERNA, Swains.

Sub Genus STERNA, L.—*Sea Swallow*, or *Tern.*—*Kaghuzee*, H.

397.—*S. melanogaster*, Temm.—*S. acuticauda*, Gray and Hardw., Ind. Zool.

This *Tern* I have found all over the country, frequenting tanks, and more especially rivers.

398.—*S. similis*, Gray and Hardwicke, Ill. Ind. Zool.

Found in the same localities as the last, and still more common and numerous.

Length $11\frac{1}{2}$ inches; wing $9\frac{1}{4}$; tail 3 $\frac{3}{10}$th; bill at front 1 $\frac{1}{16}$th: tarsus $\frac{9}{10}$th; bill dark lake colour; feet and legs black.

399.—*S. Seena*, Sykes.

Spread throughout all the Peninsula, but less common than the last.

Bill bright yellow; legs red. Length 17 inches; wing 11; tail $8\frac{1}{2}$; bill at front $1\frac{1}{2}$.

400.—*S. anglica*, Montagu.—*Marsh Tern.*

Common all over the country.

Length about 16 inches; but it varies a good deal in size: of one 16 inches long, the wing is $13\frac{1}{2}$, $2\frac{1}{2}$ inches beyond the tail, which from base is nearly 6; bill and tarsus black.

401.—*S. minuta*, L.

I have seen this pretty little *Tern* most abundant in the west coast, at the mouths of rivers, but have also met it above 200 miles inland.

Length nearly 9 inches; wing $6\frac{1}{2}$; half an inch beyond the tail, which is nearly 3; bill at front $1\frac{2}{10}$; yellow, dusky at the tip; legs orange; tarsus $\frac{7}{10}$ths.

402.—*S.* ——— .—New species?

Descr. Head and back of neck sub-crested deep glossy black, plumage above light grey; beneath white; tail much forked; lateral feathers white; bill yellow; legs black.

Length $17\frac{1}{2}$; wings $12\frac{1}{2}$; 1 inch beyond tail; tail $6\frac{1}{2}$; bill (at front) 2 $\frac{3}{10}$ths; tarsus 1 inch.

I have only found this very elegant species on the sea coast, on the west of India, at the mouths of rivers.

403.—*S.* ———.—New species?

Back, wings and tail pale grey; rest of body white, except a blackish grey streak through the eye; head and neck with a tinge of grey.

Length $14\frac{1}{2}$ inches; wing 11; tail 4; bill at front 1 $\frac{3}{10}$th; tarsus $1\frac{1}{2}$ bill black, within orange red; legs and feet dusky sienna reddish.

This species appears tolerably common on the east coast of the Peninsula, near Madras.

404.—*S.* ———.—New species.

Descr.—Head and nape blackish; feathers edged with white; body above grey, beneath white; bill deep lake red; legs sienna.

Length 11 inches; wing $8\frac{1}{2}$; tail 3; bill at front 1 inch.

Genus THALASSITES, Swains.

405.—*T.* ———.—New species?

Descr.—Head and upper part of the neck glossy black, above light grey; beneath, and tail white; bill orange red; legs black.

Length 21 inches; wing 16, reaching 3 inches beyond the tail, which is $5\frac{1}{2}$; bill at front 2 $\frac{6}{10}$th; tarsus 1 $\frac{8}{10}$th.

I have found this large *Tern* most abundant on the west coast of India, at the mouths of rivers, but also far inland, frequenting tanks. The young bird differs in the head being spotted white and black, instead of being pure black.

Genus LARUS, L.—*Gull.*

406.—*L. brunnicephalus*?.—New species?.—*Brown-headed Gull.*

Descr.—Hood pale ashy brown, terminated by a darker edge; mantle and wings light grey; the rest of the body pure white; bill and legs deep lake red; a half circle of white feathers round the back part of the eye.

Length 19 inches; wing 14; tail nearly 6; bill at front $1\frac{1}{2}$; tarsus 2.

I have found this *Gull* common on the west coast of India, and also inland above 200 miles, frequenting rivers and tanks. A *Gull* which corresponds exactly in size with this one, and which I have usually seen in company with it is probably the young bird. It differs in wanting the brown hood, and in the tail being broadly tipped with black.

407.—*L.* ———.—New species?

I possess only a young specimen of this *Gull* in the usual mottled plumage, so shall content myself with giving its measurements. It was shot 200 miles inland.

Length 2 feet; wing 18 inches; tail 8; bill (front) 1 $\frac{8}{10}$th; tarsus 2 $\frac{6}{10}$th; bill and legs yellowish.

I have seen other species of *Gull* on the sea coast, but not having procured specimens, refrain from noticing them at present.

I have now brought to a conclusion this imperfect Catalogue, the chief object of which has been an enumeration of all the birds found in Southern India; the few brief notes I have added having been hastily drawn up, without method, to relieve the monotony of a bare list of names. I purpose in a future, and I hope, an early number, to add a supplement, containing the description of a few additional species I have obtained since the first parts of the Catalogue were printed—and also to correct several errors of nomenclature, and to add some brief additional notes on the habits and geographical distribution of a few of the species, which more recent and extended observations have enabled me to offer.

The specimens on which my Catalogue was founded, are now on their way home to a distinguished Ornithologist, and as soon as they are examined, and identified by him, I will in another supplement give the result of his examination, and a synopsis of all the species with their correct names and synonymes. By way of rendering this part more generally useful, I may probably also add a synopsis of the different genera found in India, and a brief description of all the species, so that it may serve as a text book for the Peninsular birds, and supply to the ornithologist in this country, the want of the numerous bulky and ill-compiled works of reference, which often perplex as much as they inform.

I trust also to be able to add to this, through the kindness of Walter Elliot, Esq., a list of the names of many of the birds in several of the native languages, and in the native characters, by which collectors may be much facilitated occasionally, both in the acquisition and identification of various species. At a future period, I hope that my observations on the habits and manners of many of the Indian birds may be so far extended as to enable me to publish a much more full and enlarged account than I am now able to attempt, and illustrated by coloured figures of many of the unfigured species. To enable me, however, to effect this, I look confidently for the assistance and co-operation of other observers, without which it will be impossible to present any thing like a tolerably complete history of Indian Ornithology; for, from the nature of a tropical climate precluding much or constant exercise on the open air, and the necessary occupations of most of the residents here, no one individual can ever expect to give from his own observations a faithful transcript of the habits and manners of even a limited number of the birds; and it is only from a series of detached observations, and from many individuals co-operating together, that such a much wished for result can be obtained.

With this view, I earnestly solicit any of the readers of this Catalogue, (who may have the opportunity and inclination), to forward me any observations they may make, and let them not deem the smallest scrap of information too trifling to send. I would more particularly request further intelligence regarding the nidification of the Indian birds, of which so little is known, their various notes, food, and manner of feeding, times of appearance and disappearance of migratory species, names in any of the native languages, and any tales, proverbs or superstitious ideas the natives may have concerning them. There are also a few desiderata which I shall here enumerate, and any individuals who may have it in their power to give any information regarding them, will receive my best thanks.

No 6.—Specimen of the large *Fishing Eagle* of the Chilka lake, which I suspect may be the *Hal. ichthyætus*, No. 8 of the Cat.

No. 34.—Specimen and descriptions of the *Besra.*

Specimen and description of the *Kandesrah* of Indian Falconry, a species of *Sparrow-hawk*, I suspect, nearly allied to the *Besra.*

Specimen or description of the *Gorbesrah* which I suspect is the same as my No. 36, a species of *Goshawk*, differing in its smaller size from the *Baz* or true *Goshawk.*

No. 268. *bis.*—Whether the *Ortygis Taigoor*, of Sykes, is a distinct species, or the young bird of the *O. pugnax.*

No. 282.—Any information regarding the *Black Florikin*, its time of appearance in different districts, at what season it is seen in a state of change, &c. &c. &c.

II.—*On the General Application of Low Steam Power to all Vessels, instead of Sails.*

It is very surprising that though so much has been done in applying Steam Power to move vessels at high speeds for the conveyance of passengers, it does not appear that as yet, any considerable trials have been made of it, for the conveyance of merchandize at moderate rates. The quantity of fuel and power of engine requisite to propel a ship at high speeds is so great, that for a voyage of any considerable length, the vessel is almost taken up with them, leaving so little room for merchandize that it will not answer, except principally employed in the transport of passengers. But this is no reason that it should not answer to use

steam for the transport of merchandize at low rates, and the subject is well worthy of investigation. The question is, whether merchandize can be transported at the *rate* it is at present conveyed by sailing vessels, cheaper or safer by steam; or whether it can be conveyed at the same *cost* as in sailing vessels, but quicker by steam.

It seems strange to conclude, that, because it will not answer to use steam for the common purposes of commerce at high speeds, therefore it will not be advisable to use it at moderate rates. On land, horses are used at high speeds for passengers, and at low rates for goods, and on examination it may be found to be just the same with Steam Power at sea. The two cases are in effect precisely similar; in moving land conveyances the resistance at higher speeds does not increase, but animal power rapidly diminishes, which is the cause of the rapid increase of cost. In steam vessels, there is indeed no less of power at higher speeds, but the resistance to a vessel moving through the water rapidly increases, and hence the effect is the same as in land conveyance; viz. a rapid increase of expence. In the one case, there is no increase of resistance, but a decrease of power as the speed increases; in the other there is no decrease of power, but there is an increase of resistance. Hence upon the first glance at the subject, it would appear probable that as it is found to answer on shore to use horses for passengers at high speeds and for goods at low ones, so it may be found in the case of steam afloat.

The best way of attempting to arrive at a sound conclusion in this case, is, to compare the actual cost of the two modes from the data we have, and then to consider what further important points there are in the matter, which it is not so easy to make subjects of calculation.

But it may be well first to consider the leading principles, which affect the motion of vessels through water. It is well ascertained that up to about 8 knots, an hour, the resistance of water to vessels increases more rapidly than in the proportion of the square of the velocity; that is, with a double velocity resistance is more than four times as great, with a treble velocity more than 9 times as great and so on. Hence to move a vessel a certain distance, it takes more than four times as much fuel and more than four times the power of engine to do it at a double speed, and more than 9 times as much fuel and steam power, to do it at three times the rate. This appears to hold good up to a certain speed, about 8 knots an hour, after that the resistance does not increase quite so rapidly, but still in rather a greater proportion than the velocity. Hence if a vessel can carry sufficient fuel to go 4000 miles at the rate of ten knots she can carry enough to go about 12,000 at 5 knots, and more than 50,000 miles at 2½ knots. But further, as in going at the double speed the engine must

not only overcome more than a proportional resistance, but also do it in half the time, the actual power of engine employed for 10 knots speed must in fact be about 6 times the power of that required for 5 knots or about 10 times, what is necessary for 4 knots, though it will only be in action half and two-fifths the time respectively, in accomplishing the same distance.

Hence if a vessel of 400 tons required at 10 knots an hour an engine of 180 horse power, and 50 tons of coal per 1000 miles, she would at 5 knots an hour require an engine of 30 horse power, and $8\frac{1}{3}$ tons of coal for that distance; and at 4 knots, an engine of 18 horse power and 5 tons of coal for the same. This has been proved by experiments in many ways, to be about the proportionate power required for the speed.

And with respect to the effect of the size of the vessel, it is also well known that the resistance to a large vessel is less in proportion than to a small one, that is, if a vessel for instance of 1600 tons, required an engine of 400 horse power for any given speed, or one horse power to every 4 tons, a vessel of $\frac{1}{8}$ that size, or 200 tons, would require double that proportion, or 100 horse power, being 1 horse power to every 2 tons; the cause of this is obvious, that the body of water to be removed by any vessel is in proportion to the breadth and depth multiplied together, but her capacity is in proportion to the breadth, depth and length multiplied together. Thus a vessel of double dimensions will displace four times as much water in moving, and consequently meet with four times the resistance, but her capacity will be increased 8 fold, so that while she carries 8 times as much cargo, she only meets with 4 times as much resistance, and consequently requires in proportion to her tonnage, only half as much power. It is on this ground, that large vessels are found to answer better as steamers than small ones, and it was because this principle was forgotten, that it was so confidently asserted, that in the present state of the knowledge of steam navigation, a vessel could not carry fuel enough to cross the Atlantic, the calculations being made from small vessels without allowing for this consequence of an increased size.

Hence we find that in steam navigation, the same vessel requires for a double speed more than double the quantity of fuel, and about six times as powerful an engine to *go a certain distance.* The same vessel to go *for a certain time* at a double speed, requires about six times the quantity of fuel, and six times the power of engine, but she will go in that time double the distance. For a given speed, a vessel of eight times the tonnage as another, will only require four times as much fuel, and four times as great a power of engine.

These points are so well known and have been so often ascertained practically, that it is not necessary to attempt the proof of them here.

The point that remains is simply to estimate from these principles and from the known cost of the various items in sailing and steaming, which would be cheapest at different rates of speed, to work a vessel by sails or by steam.

For this purpose the actual cost of working a vessel of 380 tons, new measurement, in the Indian seas for near two years may be taken, as a subject for comparison.

EXPENCES OF A SAILING VESSEL.

First class vessel of 380 tons new measurement, above an average sailer, and working well, carrying 400 tons of a mixed cargo.

COST.

Hull	3600 £
Fitting for sea in every respect	2400
Total cost	6000 £

EXPENCES.

	£
Insurance at 6 per cent	360
Commander	360
1st Officer	120
2d do.	72
4 Sucunnies (helmsmen)	120
Syrang and 2 tindals	66
China carpenter	48
Butler and boy	24
28 Lascars	336
Victualling 38 persons	47
Renewing sails	80
Do. spars	40
Repairing hull, 2½ per cent. (*including coppering*)	90
Sundries, paint, &c	50
Port charges	200
Replacing hull, 3 per cent	108
Steam tug hire	30
Total expences per annum	2151 £

The actual distance run by above vessel measuring the nearest line from port to port was 26,500 miles, in 23 months, or 13,800 miles per annum; and the number of days actually under way was 303, giving 88 miles distance per day, or 3¾ knots per hour, for the average of a good sailing vessel in the Indian seas, allowing only the real distance between the ports, which is done in order to compare her distances with those of a steamer.

EXPENCE OF STEAMING.

Vessel of the same capacity, viz. measuring 380 tons, and capable of carrying 400 tons of a mixed cargo, but built of course upon the model of a steam vessel, that is with greater length and less draught of water, propelled by a 30 horse engine.

COST.

	£
Hull	3,400
30 Horse engine, &c.	1,200
Anchors and cables.	200
Set of lug sails and moveable masts, in case of accidents.	200
Total cost	5,200£

Expences.	£
Insurance at 4½ per cent	234
Commander	360
Officer	120
Engineer	300
2d Do.	120
Armourer	120
6 Stokers	72
1 Syrang, 1 tindal, 10 lascars	168
China carpenter	48
Butler and boy	24
Hired labour in port in consequence of the small crew.	100
Victualling 21 persons	24
Repairing hull 2 per cent.	108
Renewing engine 9 per cent.	108
Repairs of engine 5 per cent	60
Oil.	12

Steaming 15,100 miles at 108 per day, at 8-lbs of coals per horse

power, per hour, 350 tons at 16 shillings............	280
Total expence per annum.	2380
Deduct an account of 800£ less capital than in the case of the sailing vessel, int. at 4 per cent..	32
Total expense of steaming 15,100 miles.......	2348
Do. of 13,800 miles, the distance run by the sailing vessel in a year.	2150 £
Expenses of sailing vessel same distance.	2150 £

That is by the above estimate, the expences of working the vessel by steam and by sails is precisely the same. It remains to calculate the loss of tonnage and consequently of freight that would be the consequence of carrying the engine and fuel.

The average length of voyage made by the above vessel was 1800 miles each ; supposing the steamer to carry on an average, coal for 2400 miles, or 23 days, she would require, of coals.... .... 58 tons.

Weight of engine........ .. .. 20 tons.

Total.......... 78

But as she would require scarcely any space for sails, and the various stores of a sailing ship, we may deduct on that account, especially as her upper deck will be quite clear........... 40

Actual loss of feight caused by engine......... 38 tons.

Further, as the sailing vessel would not be full every voyage, but probably be at least 38 tons deficient in an average of her voyages, the steamer would in effect suffer no loss compared with the sailing vessel in carrying her engine and fuel.

It is next necessary to ascertain what would be the comparative speed on the two systems ; it has been before shown that the speed of the sailing vessel averaged $3\frac{3}{4}$ miles per hour, and it must be remembered that this vessel averaged considerably above merchant vessels in general. The power of steam allowed is 30 horse for a vessel of 380 tons new measurement, which would be sufficient to propel her at 5 knots per hour, in smooth water and calm weather ; she would then go

6 with a strong leading wind and following sea (without sails), and 3 against a strong head wind ; and in case of a gale of wind she would easily go a head 2 knots keeping the sea on her bow. Her average then in the Indian seas could not be reckoned at less than $4\frac{1}{2}$ knots or 108 miles per day, while a fast sailing vessel only averaged $3\frac{3}{4}$ knots, the speed of the steamer would therefore be greater by $\frac{1}{5}$, or she would perform a voyage in 48 days, which the sailing vessel would not perform in less than 60 days. The steamer, it is to be observed, carries no standing masts or rigging whatever, but merely 3 light masts with lug sails which she can set up in case of accidents. Whether it might be worth while to use those sails regularly in the trades or in any leading winds, is a subject for further calculation.

For the safety of the two modes, there can be no room for doubt that the steamer having no masts and sails, would be free from most of the dangers to which sailing vessels are exposed ; she would in fact be always in that state to which sailing vessels are obliged to reduce themselves when they have no alternative, in order to avoid destruction, viz. by cutting away their masts.

The conclusion therefore is, that it would be quite as cheap to work a merchantman by steam at $4\frac{1}{2}$ knots per hour, as by sails at $3\frac{3}{4}$ knots in voyages of moderate length, that is not exceeding on the average 2,400 miles, or varying from 1,000 to 4,000 miles without taking in coal, and that it would be far safer.

But in the above comparison, ordinary voyages only are supposed.

To show more strongly the effect of steam power, we may take the case of a voyage in which the vessel was delayed by accidents, such as frequently occur to sailing vessels ; this vessel lately sailed from Singapoor to Madras ; on her passage she lost one or two of her masts in a white squall, and was obliged to put back into Penang ; and on her making Madras, she encountered so strong a current that she was carried to lee-ward of her port ; and in consequence she was 80 days in completing her voyage.

Comparison of profits of a steamer with the Ship ——— from Singapoor to Madras.

Time occupied in voyage	80 days
Add for loading and discharging	10
Total time of voyage....................................	90 days

Total expence of such a vessel per annum........2151£

Do. for 3 months................ .....£538
Actual receipts of the same vessel...... 700

Net profits........ .... 162£

Do. per annum .... 650£

which upon 6,000£ is.. .... 11 per cent.

Calculation for steamer.

Expences (inclusive of coal)—per annum............2,100£

Do. for 3 months..... ...... 525 £

FUEL.

	Miles.
Madras to Penang....................	1,300
Penang to Madras (in part)	1,000
Madras to Penang	1,300

Coal for miles....... ....3,600 at $2\frac{1}{4}$ tons
for 100 miles, 82 tons at 17 Rupees...... 140
Penang to Singapoor (4 times)..........1,500 miles
Penang towards Madras..................... 300

Wood for.......... ....1,800 miles
at 5 tons, per 110 miles, 80 tons at 2 Rs. 16

Total expences for 3 months....... .... 681 £

The steamer has a 30 horse engine with which she averages $4\frac{1}{2}$ knots, which she would do with ease, as she will encounter no head sea, a great part of the voyage will be in perfectly smooth water, and there will be very little head wind. She takes in at Madras coal to work her to Penang, 1,300 miles, and also to work her part of the way back, viz. 1,000 miles, in all 2,300 miles at 100 miles for $2\frac{1}{4}$ tons, making 53 tons. At Penang she deposits coal for 1,000 miles, taking in wood both there and at Singapoor and Malacca if necessary, for the Straits and also for the first 300 miles out of Penang towards Madras. The wood is taken on deck, and does not interfere with the tonnage.

Tonnage taken up by fuel and engine.

	Tons
From Madras; coal	53
Engine	20
	73
Towards Madras; coal	23
Engine	20
	43
Average ....tons	58
Deduct on account of tonnage saved in stowage of sails and stores	40
Net loss	18 tons
Tonnage of vessel	400
Available for freight	382 tons

As she would perform the voyage of 1,660 miles in 15 days, and allowing 10 for loading and discharging, she would in 90 days perform 3½ voyages, and allowing her to carry 360 tons each time.

Receipts.	£
360 tons of freight at 20 Rupees	720
Add profit on 2 passengers each trip	40
Receipts	760
Or for 3½ voyages	2660
Total receipts in 3 months	2660
Deduct expences	680
Net profits	1980
Or per annum	7920

Which upon an outlay of 5200 £ is 130 per cent per annum.

The above remarks and calculations refer chiefly to a vessel worked with a very small power of engine, viz. 1 horse to 13 tons, in a vessel of 380 tons; it should now be considered what would be the effect of working with rather a higher power, though still one far short of that of the present passenger steamers.

STEAMER OF 380 TONS, WITH A 50 HORSE ENGINE.

COST.

	£
Hull	3600
50 horse engine	2000
Anchors and cables	200
Masts and sails (3 lugs)	200
Total costs	£6000

EXPENCES.

Insurance at 4½ per cent	270
Commander	360
Officer	120
1st Engineer	300
2nd do.	120
Armourer	120
Carpenter	48
4 Sucunnies	120
1 Syrang, 1 tindal, 10 lascars	168
6 Stokers	72
Butler and boy	24
Victualling 19 persons	24
Hired labourer in port	100
Repairing hull 2 per cent	72
Sundries, paint, &c.	50
Replacing hull 3 per cent	108
do. engine 9 per cent	180
Repairs of do. 5 per cent	100
Oil	20
	2376

Coal 26,500 miles at 132 miles per day or 240 days, in 19½

months, 870 tons, or 500 tons per annum at 16 S...........	400
Total cost per annum	2776 £

But as the sailing vessel takes 303 days to run that distance, while the steamer would take only 204, there would be 99 days saved out of the 23 months occupied by the former in her voyages; and while the former run 13,800 miles in the year, the latter would run 16,200 in that time; hence

	£
Proportional expence of steaming 13,800 miles...............	2360
Expence of sailing do. as before....................	2151
Do. of steaming above sailing........	210

That is; the expence of working a vessel of 380 tons, with a steam power of one horse to $7\frac{1}{2}$ tons, would exceed that of sailing the same distance, or of steaming with a power of 1 horse to 13 tons, by £210 in 13,800 miles or by about $\frac{1}{11}$th.

Thus it appears that there is a certain speed at which steam vessels can be worked as cheaply as sailing vessels, but at a little higher speed, the steam power is more expensive.

The loss of freight in consequence of the space occupied by the coals and engine, must next be calculated.

	Tons
Coal for 2,400 miles as before, being 18 days at $4\frac{1}{4}$ tons per day.	76
Engine..	30
Total tons...	106
Deduct as before on account of saving in ship's stores	40
Loss of tonnage.........................	66
But as the sailing vessel would be deficient of freight on an average at least 30 tons, the actual loss of freight would be................................	36
	or $\frac{1}{11}$

	£
Allowing for this, the cost of conveying 350 tons of freight in the steamer would be	2600
And in the sailing vessel..........	2150

Expence of steaming at this speed above that of sailing...... £450

or $\frac{1}{5}$

In the above calculation, the steamer is supposed to average 132 miles per day, or $5\frac{1}{2}$ knots per hour. The speed of a vessel of 380 tons, with a 50 horse engine in smooth water, would be about 6 knots, 4 against a strong head wind and sea, and 7 with a fair wind and following sea (without masts and sails) her average would be at least $5\frac{1}{2}$ knots. This is exactly half as much again as the average of the above fast sailing vessel. According to this the voyages of the steamer, would be performed in two-thirds of the time required by the sailing vessel, but in reality they would probably take considerably less than that.

Thus it appears, that to work a vessel with such a power of steam as would ensure the voyages being performed in two-thirds of the time of a sailing vessel, it would cost one-fifth more ; and there can scarcely be a doubt that the other advantages of steam, would far more than compensate for this increase of expence ; or we come to the conclusion ;

That it would answer as well to work a vessel by steam at an average rate of $5\frac{1}{2}$ knots, as by sails at $3\frac{3}{4}$ knots, measuring the distances on the nearest line from port to port, supposing that the average length of her voyages without taking in coal, did not exceed 2,400 miles, or that they varied from 1,000 to 4,000 miles, and hence that by the use of steam without any masts or sails, commerce might be carried on in most parts of the world at a speed exceeding by one-half that ordinarily attained at present by sailing vessels, without any increase of expence, and with much greater safety.

If a higher speed than this is required, it must evidently be purchased at a rapidly increasing cost, though this might answer in particular lines of trade, and especially where there was a considerable portion of passengers. And it is evident, that were this system extensively introduced, the carriage of passengers would form a much more considerable item of traffic ; for the safety, certainty, comfort and speed of this mode, would increase the number of travellers by sea probably four-fold. The loss of time and uncertainty of passages in sailing vessels, besides their discomforts, make it almost impracticable for men much occupied, to move from one port to another, and they can only do it in very urgent cases. Powerful steamers working at ten knots, would of course be still more effectual, but first, they could not afford to carry passengers, but at a high rate of payment, and secondly, they are not likely at present to be established except on some main lines of intercourse. At the same time, such a

means of proceeding at a high speed along a few main lines, would greatly increase the number of passengers on the subordinate ones.

In all that has been said hitherto, it is supposed that the vessel has no standing masts or rigging and never uses sails. She has three small masts on board to be set up on the deck, with temporary rigging on which can be set three lug sails containing in all about $\frac{1}{3}$ of the full spread of canvass for a ship of her tonnage; these are merely kept in case of an accident which deprives the vessel of the use of her steam power.

Whether it would be advisable to use these sails occasionally when there was a steady leading wind is a separate question, which may now be considered.

The effect of a spread of canvass equal to $\frac{1}{3}$ of that of a ship under full sails, would be $\frac{5}{8}$ of her full speed, that is if under full sail she went 8 knots, with a leading wind, she would run 5 knots with $\frac{1}{3}$ of that quantity of canvass when the wind is on the beam, or quarter, but with the wind nearly aft, it would make a less difference than that. Further as she would be able to carry such low and small sails, without any weight of masts and yards above them, in a much heavier breeze than a sailing ship could carry full sail, the average difference of rate in the two cases would be much less than 5 to 8. There is a third point which would still further reduce this difference, viz. that as such a vessel would never have to beat or carry a heavy press of sail, she would of course be built on the model of a steamer, that is with a light draft of water, and great length, and consequently would with a leading wind require less sail than such as are built on the model of a sailing vessel, to give her the same speed. Allowing for these three considerations, the average speed of such a vessel with a leading wind could not be taken at less than $\frac{3}{4}$ of that of a full rigged ship. Hence if a sailing vessel averaged 7 knots while running down a trade, the speed of the steamer from her sails, and without using her engine, would be $5\frac{1}{4}$ knots and she might therefore put out her fires in such circumstances, without going below her average speed more than $\frac{1}{4}$ knot, if the vessel of 380 tons has a 50 horse engine; and with a gain of $\frac{3}{4}$ knot if she has only a 30 horse engine. Or she might use both steam and sails. In such cases, if she could run $5\frac{1}{4}$ knots by wind only, and $5\frac{1}{2}$ knots by her engine alone, she would have a speed of at least $7\frac{1}{2}$ knots, if she used both together. That is, such a vessel with a 50 horse engine would by the additional use of her sails run at least two knots above her average, and at least one knot more than she would go with her engine and a strong wind nearly aft and a following sea, but without sails. And such a vessel

with a 30 horse engine would run at least 7 knots an hour, or 2½ above her average, and one knot more than she would go under the most favourable circumstances without sails. Supposing then that such vessels used light sails occasionally, such as when running with a trade or monsoon on or abaft her beam, the calculation for her would be as follows ;

STEAMER OF 380 TONS WITH 30 HORSE ENGINE.

	£
Expences as before	2050
Renewing and repairing sails per annum	60
	2110
Coal for steaming 15,800 miles at 120 miles per day, 132 days at 8 lbs. per horse power per hour, 340 tons at 16 S.	270
Total expence of steaming 15,800 miles	2380
Do. do. 13,800 miles	2080
Do. do. of sailing do.	2150
Difference in favour of steaming	70 £

The speed of such a vessel would be 3 knots against a head sea and wind, 5 knots in smooth water and calm weather, and 7 using her sails with a trade of average strength; her average could not be less than 5 knots, while the sailing vessel averages only 3¾ knots ; or the steamer would perform her voyages in three-fourths of the time of the sailing vessel. The sailing vessel was 303 days at sea out of 23 months, running a distance of 26,500 miles ; the steamer would in this case accomplish that distance in 220 days, and consequently allowing the same time in port for both vessels, she would perform the same work in a little more than 20 months, or at the rate of 15,800 miles per annum ; for this, allowance has been made in the above calculation.

Hence it appears that a vessel of 380 tons, worked by an engine of 30 horse power, fitted with movable masts and 3 lug sails to be used when there is a steady leading wind, would be worked cheaper at an average speed of 5 knots than a sailing vessel at 3¾ knots ; that is, she would at less expence perform her voyages in ¾ of the time of a sailing vessel.

Or if such a vessel with a leading wind, made use of wind only, she

would on an average of voyages save about $\frac{1}{3}$ of her fuel, and hence she could run 6,000 miles with the same fuel, as she would require for 4,000 miles if she made no use of her sails, and as her speed in that case would be 3 against wind and sea, 5 in calms, and $5\frac{1}{4}$ on an average, using her sails only ; her total average would be about $4\frac{3}{4}$ miles or one-fourth more than that of a sailing vessel. That is

A vessel of 380 tons, with a 30 horse engine and fitted with moveable masts and light sails to be used in leading winds, without steaming at such times, cou'd be worked as cheaply as a sailing vessel, in voyages of from 1,000 to 7,000 miles without taking in coals, at á speed $\frac{1}{4}$ greater, or she would in her voyages save one day in 4.

The effect of occasional use of sails in such a vessel, with a 50 horse engine, may next be examined.

Steamer of 380 tons with engine of 50 horse power, using light sails occasionally.

	£
Expences as before, omitting coals	2376
Renewing sails, per annum	60
	£ 2436
Coal for 16,800 miles at 150 miles per day at 8 lbs. per horse power per hour, 480 tons at 16s	384
Total expense of steaming 16,800 miles	2820
Do. of do. 13,800	2320
Do. of sailing do.	2150
Excess of expense of steaming	170
	or $\frac{1}{12}$

The speed of this vessel would be 4 knots against a head wind and sea, 6 knots in smooth water and $7\frac{1}{2}$ using her sails also ; taking her average at $6\frac{1}{4}$ knots, she would perform her voyages in $\frac{2}{3}$ of the time of the sailing vessel. She would have performed the distance run by the latter, viz. 26,500 miles in 177 days, instead of 303, saving 4 months out of 23, the whole time occupied by the sailing vessel, and running in the year 16,800 miles. Allowing the steamer to lose as before calculated $\frac{1}{11}$ of her freight, the proportional expence for the same amount of tonnage would be

	£
Expence of working steamer as above	2320
Add for loss of tonnage $\frac{1}{11}$	220
	2540
Expence of sailing vessel	2150
Net increase of expence in steaming	£390
	or not $\frac{1}{5}$

Hence it appears that at an increased expence of less than $\frac{1}{5}$, a loss which there can be little doubt would be far more than compensated by the additional passengers, and other advantages hereafter enumerated, vessels could by this means be worked at a speed increased from $3\frac{3}{4}$ knots to $6\frac{1}{4}$ or in the proportion of 3 to 5, or a voyage which now takes 60 days would be performed in 36. That is

That a vessel of 380 tons, with a 50 horse engine, and using light sails in strong leading winds, would be worked as profitably at 150 miles a day, as a sailing vessel at 88 miles per day, or she would perform her voyages in $\frac{3}{5}$ of the time of a sailing vessel with far greater safety, certainty and comfort to all on board; voyages ranging from 1000 to 4000 miles without taking in coal.

The above calculations are made from the actual expences and voyages of a fast sailing vessel, very profitably employed in the Indian seas. She can take in coal at Calcutta, Madras, Bombay, Singapoor and Sydney, and as she can obtain no freight on the return voyage from Sydney, she could bring back a full cargo of coal, and deposit part of what she does not use at P. Essington or King George's Sound, according as she returns by Torres Straits or C. Lewin, and part at Anjer, Singapoor or any convenient port, as may best suit her. Or she could have coal brought up by the numerous vessels sailing in ballast from Sydney for India, at a moderate cost. With a depôt of coal at P. Essington, King George's Sound and Anjer, she would never have to steam more than about 2000 miles without taking in coal, and the average distance without a fresh supply would not exceed 1800, while the calculations allow an average of 2400 miles.

It must also be remembered that the vessel used for comparison was undoubtedly much above an average sailer, so that the gain of speed and time by the use of steam would be certainly on an average greater than the calculation given.

We may now take a new case for examination, and that the comparison may be as complete as possible, the case of a vessel employed to carry coal, and without passengers, on as long a voyage as it can be necessary to carry coal, may be investigated. This must be considered an extreme case, for if it will answer to carry coal on a long voyage by a steamer, there can be no doubt that it will answer for any thing else.

Vessels are sent from Llanelly in Wales, to Bombay with coal for the steamers there. They are quickly loaded, and get the coal at about 7s. a ton, and receive from 35 to 40s. freight for it. A vessel making an average voyage fully loaded with coal, will perform the passage in 120 days, and complete her trip, so as to be ready to receive another cargo in about 5 months.

Expence of a sailing vessel of 600 tons, taking out 900 tons of coal.

	£
Cost of hull	6000
Fitting for sea	3800
Total cost	£9800

EXPENCES.

	£
Insurance at $4\frac{1}{2}$ per cent	450
Commander	120
2 Officers	102
Carpenter 60£, boatswain 36£	96
	768
Steward 36, cook 36	72
30 men at 30£	900
Victualling 3 officers	135
Do. 34 hands at 1s. per day	612
Renewing sails	50
Rope	40
Spars, &c	30
Pitch, &c	25
Repairing hull 5 per cent	300
Replacing hull $3\frac{1}{2}$ per cent	210
Port charges	60
	3202

Sundries	40
Total per annum	3242
Do. for 5 months	1350 £

Steamer of 600 tons.

	£
Hull	6000
Engine 30 H. P.	1200
Masts and sails	280
Anchors and cables	300
Total cost	£7780

EXPENCES.

	£
Commander and officers	222
Engineer	144
Armourer (capable of taking charge of engine)	84
4 Stokers	240
Carpenter	60
Steward and cook	72
10 men	300
Victualling 5 as officers	225
Do. 17 at 1s.	300
Renewing sails and ropes	30
Oil and pitch	20
Repairing hull 2½ per cent	150
Replacing hull 3½ per cent	210
	2057
	£
Repairing engine 5 per cent	60
Replacing do. 10 per cent	120
Insurance 3½ per cent	273
Port charges	60

Sundries.. 40

Expences per annum..........£2610

Do. for 4 months and 5 days ....905 £

Coal for 95 days, at 8-lbs. per horse power per hour, 2½ tons per day at 7s... 83

Total expence for 640 tons 11,000 miles.....988 £

		s.	d.
Do. do. per ton..............	£1	11	6
Expence by sailing vessel 900 tons..........	1350		
Do. per ton..................	£1	10	0

That is the expence of steaming would exceed that of sailing by 1s. 6d. per ton carried, but 25 days would be saved in the voyages.

PROFITS ON SAILING.

Supposing the freight to be 2£ per ton. £

Profit on 900 tons at 10s. (in 5 months) 450

Proportional profit in a year.. 1080

Which upon a capital of 9800£ is ....11 per cent.

PROFITS ON STEAMING. £

640 tons at 8s. 6d. (in 4 months 5 days)... 272

Proportional profit per annum......... 782

Which upon 7780£ is ....10 per cent.

That is the profits upon the voyage by the sailing vessel would be 11 per cent. and in the steamer only 10 per cent.

In the above estimate, the coal carried by the steamer is thus reckoned

	Tons
Total coals conveyed in sailing vessel....	900
Deduct coals consumed 240 tons, engine 20 tons.	260
Coal conveyed by steamer......	640 tons

The sailing vessel in this case, with a full cargo of coal, is supposed to make her voyage in 120 days, and as the distance measured on the nearest line is 11,000 miles, this is, at the rate of 92 miles a day, or $3\frac{3}{4}$ knots per hour. The steamer is supposed to go $4\frac{1}{2}$ knots in smooth water, on an average against the wind 3, and 7 with a good breeze and steam together, averaging on the whole $4\frac{3}{4}$ knots, which would make her voyage 95 days. It is to be observed that the steamer is built with a light draft of water, and of great length like other steamers, and not like a sailing vessel, so that light sails would give her much greater speed than the same quantity set on an ordinary sailing vessel. Also that she consumes 240 tons in the course of her voyage, so that her cargo taking the average of the voyage is 120 tons less than that of the sailing vessel. In the course of her passage, she would not encounter a head wind on many days as she would of course choose her route, so as to avoid them as much as possible; for instance after crossing the line she would keep so near the West Coast of Africa as to avoid the steady S. E. trade.

But if upon estimating such a case as the above, there should be any thing like reason to believe that it might answer, how evident it must be, that for the first class of passenger ships to India it would certainly be in every respect the most eligible plan. Some trials are already making on the use of steam of small power in such vessels, and there cannot be a doubt that it will be a great advantage, but in applying it as at present to assist a full rigged vessel, the main advantages are lost, viz. safety, convenience and comfort. As long as ships carry masts, they must be exposed to many dangers which they would not otherwise encounter. By getting rid of the standing masts and rigging altogether, the vessel is made almost independent of the weather, she can scarcely ever receive any damage in the open sea, and even on a lee shore, a very moderate power of engine would enable her to keep an offing. She would be built on a steamer model with which she would require a much more moderate power of engine than the present vessels to give her the same speed; besides which, both from her greater length, and from her upper deck being unencumbered, she would have about twice as much accommodation for passengers as a sailing vessel of the same tonnage. Further, she would be always nearly upright, and as she would be mostly in those parts of the ocean, where she would find the lightest winds and smoothest water, she would seldom have much motion. When it is thus considered that such a vessel would have such decided advantages over any vessel with standing masts, in safety, comfort, convenience, speed and extent of accommodation, and it has been already shown how near she would

come to the latter in point of expence, there seems no room for doubt that there could be no comparison between the two, as passenger ships. In such a vessel the passengers would scarcely be disturbed one night in a whole voyage.

But perhaps the most important application of this system at present would be to the emigration to New Holland. Those noble colonies afford an unlimited field for the employment of all classes of people, and the grand desideratum above all others for them, is the means of a safe, convenient, rapid and cheap transport of emigrants. At present the governments of the different colonies allow 20£ for every adult male, and a proportional sum for women and children. A vessel of 600 tons, new measurement is allowed to carry about 240 persons. Such a vessel will ordinarily draw about 17½ feet of water, with a length of 125 feet. A vessel of the same tonnage, built as a steamer, need not draw more than 11½ feet, perhaps less; and with the same beam as a sailing vessel of the same measurement, she would have a length of 180 feet, which would give her full half as much room again for passengers' accommodation, and as her upper deck would be unencumbered, and might therefore be occupied for ⅔ of her length by passengers, her accommodations altogether would be fully double those of a sailing vessel of the same tonnage, or she could carry 480 persons of all ages. A vessel of that class is at present chartered for about 2500£, which gives about 10£ a head for each individual emigrant exclusive of their food; this costs, it is said about 3£ 10s. making the total actual expense of transport probably about 15£ a head, including sundry expences; the government allows at present 20£ for men, and the profit may be on an average 2£ a head upon all ages. The question is at what cost a vessel of this tonnage worked by steam could be taken out to New Holland, in comparison of that of a sailing vessel. An average passage at present is about 110 days, and the distance measured on the nearest line is 12,800 miles from Plymouth to Sydney, giving an average of 107 miles per day or 4½ knots per hour. A 600 ton steamer with an engine of 40 horse power would run 5½ knots in smooth water, 3½ on an average head to wind, and 8 on an average with steam and light sails while in the strong westerly winds between the Cape and Bass' Straits (about half of the voyage); giving a total average of about 5½ knots an hour, and a length of 90 days for the passage, of which the fires may be out for at least 20 days, when the westerly winds are very strong, leaving 70 days of steaming to be provided for. Her cargo at starting would then be;

	Tons
75 days coal at 3½ tons per day	260
Water and provisions for 360 persons	180
Engine and sundries	50
Baggage, &c	90
Total weight on board ...tons	580

She would of course become lighter every day, and towards the end of the voyage would have a considerably increased speed on that account, while it would not be at all necessary to have any great weight in a vessel not carrying any sails on a wind, and only very light ones when the wind was fair. Her expences would be ;

	£
Annual expences as before given, excepting coal	2610
Do. for 110 days	803 £
260 tons of coal taken in, in London at 18	231
Total expences of voyage	1040
Which for 360 persons would be per head	3 £

A sailing vessel of that tonnage would carry 240 persons, and occupy 4½ months in all on the voyage.

	£
Annual expences of a 600 ton ship as before	3240
Do. for 4½ months	1215
or per head	5 £

Hence it appears that the cost would be 5£ a head in a sailing vessel and only 3£ a head in the steamer, while the voyage would be shortened 20 days, besides all the advantages of safety, comfort and certainty already enumerated, thus giving the advantage to the steamer in a great degree, and in every respect.

The cost of provisions would also thus be reduced nearly one-fifth, causing a further saving per head of 12s. The expence of ship and feeding, would then be 6£ a head, or including sundries probably not more than 8£ a head on an average. The expence in larger vessels would, probably be still less, and there is therefore a fair prospect that the colonies might get emigrants brought out at ⅔ of what they at present pay for them ; which is further shown thus ;

	£
Actual expences of sailing vessel........	1215
Rate at which it can be chartered............	2500
Actual expences of steamer.................	1040
Proportional rate of charter..............	2100
240 persons in former gives per head........................	10 £
340 do. in latter do. do.	6 £
Saving..........	4 £
Add do. food..	0 12
Total saving.....	4 12

which, taking men and women and children together, is about ½ of what the colonies now pay for them. This too allows a profit of 1060£ upon the voyage which is probably too much, as such vessels would certainly have the choice of freight and passengers for the home voyage. They would generally go home by the Cape of Good Hope, instead of Cape Horn, which would be a much preferable passage. For half the year, they might go by C. Lewin, and the other half through Torres Straits. A vessel went home by the latter route this year, and there seems little room for doubt, that shortly it will be preferred by all vessels, as being shorter, and a fair weather-voyage almost throughout. The dread of Torres Straits for sailing vessels has now nearly passed away, and there is still less objection to a steamer making that passage than a sailing vessel. Such vessels might also be used to meet the Indian steamers at Batavia or Trincomalee. The former would take them but little out of their way, on their passage home from Sydney by Torres Straits. There is a difficulty to be got over in respect of carrying the number of emigrants proposed, as being greater than that at present allowed by law that is, if the vessel is measured for emigrants by the same rule as for tonnage, viz. taking the depth into the calculation, but if they are measured as transports are measured for troops, viz. by the breadth and length only, there would be no difficulty in the matter. If, however, the number at present allowed is in proportion to the tonnage, it would be necessary to get an act passed for this new class of vessels, and as

they would be in every respect so far preferable for conveying emigrants, there is little doubt that the act required could be obtained.

It may yet be worth while considering how far this principle might be applicable to men-of-war. The steam frigates already built, have as usual in commercial vessels, engines of great power, but they consequently are subject to the serious drawback of carrying fuel for 20 or 30 days only, and must consequently be fully rigged, which both obstructs them when steaming to windward, and encumbers their decks. Steamers of moderate power on the contrary, would have the disadvantage of being less fast, but they would carry coal for several months, and would have the whole battery on the upper deck, free from all encumbrance. It seems probable that vessels of the three classes acting together, would form the most effective squadron, that is, if it consisted of a small number of steamers of full power ; three or four times that number of steamers of moderate power, and a few sailing vessels. As men-of-war probably do not make their voyages on an average at a greater speed than 5 knots, measured on the nearest line from port to port, the proposed vessels need not have engines of greater power than would be sufficient to give them that average rate with the help of movable masts and light sails—to be used in running in a trade or monsoon, and consequently they might be perhaps one-fourth of the power of those in the present steam frigates.

A 52 gun ship, supposing her tonnage to be 2,200 tons, would require an engine of about 100 horse power to propel her at 5½ knots in smooth water, which would consume 9 tons of fuel per day, and consequently with 900 tons, she could steam at her full speed on an average, 13,000 miles, and supposing that in the course of her voyages she sailed without using her engines 4,000 miles, she would then be provided for a distance of 17,000 miles, with that quantity of fuel, which is perhaps as much as men-of-war on an average sail in 12 months, measuring the distances on the nearest line from port to port. But it would be seldom if ever necessary for such a ship to be provided with fuel for 17000 miles, as coal is now to be obtained in Calcutta and Sydney, as well as in England and North America. These vessels in action would possess almost all the advantages of steamers of full power, as they could choose their position independent of the wind, and all hands would be at liberty for the guns, while from their carrying lighter engines, they could bear heavier batteries.

Upon this review of this very important subject, there appears, to say the least, abundant reason to believe that the use of steam of moderate power in vessels of all classes is well worthy of the attention of the

merchant, the naval officer, the statesman, and the philanthropist, as well as of the iron master, the engine-maker and the coal proprietor.

Some of its advantages may be thus generally stated;

1st.—Such a vessel would be far preferable for passengers; the time of her voyages would be only $\frac{4}{5}$ of that of sailing vessels, and it would be almost certain to a day; her upper deck would be quite clear, leaving much more room for accommodations; she would be much cooler, for there would always be a current of air through her; instead of seeking those parts of the ocean where there is most wind and consequently most sea, she would always rather choose those where there were calms and smooth water; she would be so little affected by the weather that it would very rarely happen that there would be any cause of alarm from it. She would be liable to accidents from steam, but many years of experience have now proved beyond a doubt that the danger in steamers is extremely small, the number of accidents compared with the number of voyages made, being much fewer than in similar voyages in sailing vessels. On these accounts she would be sure of a much larger proportion of passengers, and at the same time be capable of carrying a greater number than a sailing vessel, so that while she would carry as much freight, she would carry more passengers and consequently be more profitable.

2d.—On account of the greater speed and certainty she would also be preferable for freight and would be sure of the most valuable freight in the market, and also she would be more generally filled than a sailing vessel.

3d.—When leaving one port for another so situated that owing to the monsoon or trade, a sailing vessel would have to make a vast circuit, she would run direct or nearly so, excepting in one or two peculiar cases, such as leaving Bombay for the westward in the strength of the south-west monsoon, but as sailing vessels could not then attempt such a voyage, she would still be on a par with them even in such a case.

4th.—There would not be half the objection to her touching at intermediate ports as to sailing vessels which are always liable to be delayed by calms and variable winds when they are going in or out of port, whereas a steamer would lose no more time by it, than was necessary to steam such a distance out of her course.

5th.—The charge of such a vessel to both her commander and her officers would be incomparably easier and more pleasant than that of a sailing vessel; nothing less than a gale of wind would make it necessary for them to undergo exposure or fatigue; the commander especi-

ally would scarcely have a cause of a moment's anxiety in a whole voyage, and even in approaching land they would be almost as much at ease as in the open sea.

6th.—From the absence of all strain from the masts and sails, the vessel would scarcely ever require repair, or be in danger of leaking, and it must consequently be very seldom that she would require to be docked; for she would never be exposed to the trial which the passenger steamers worked at high speeds undergo, in being forced with great power of steam directly through the heaviest seas at 5 or 6 knots an hour.

7th.—Such a vessel would often obtain a freight of unusual value, on account of her speed and certainty, which might make it worth a merchant's while in many cases to charter her above the ordinary rate of freight. And, indeed, it is not improbable that such a vessel would regularly command a higher freight than sailing vessels.

8th.—She would frequently obtain employment as a tug or to assist a vessel in distress, which she could do where sailing vessels would be of no use, and so become entitled to salvage.

9th.—As the time she would require for any voyage would be almost certain to a day, she would often obtain freight or charter for a short trip, while waiting for cargo for a longer one; which a sailing vessel could not venture to do, from the uncertainty of the time of her absence from port. The steamer would in this way be incomparably more handy than a sailing vessel, and would in fact probably do half as much again in the same time. For in a great prop ortion of mercantile transactions certainty as to time must cau·e a preference.

10th.—In the case of emigrant ships, which generally have more spare room in their hold than would carry the engine and fuel; the speed, the unencumbered state of the upper deck, the certainty as to time, the small number of the crew, the vessel being almost always upright, these things must give her a prodigious advantage over sailing vessels.

11th.—The same reasons as mentioned in the last paragraph, would always secure the preference of such vessels for the conveyance of troops, and indeed those advantages would be so considerable as probably to secure a higher rate of charter as transports.

12th—Is it too much to suppose that if commerce were generally carried on in these vessels, the loss of life and property would be reduced to one-fourth of what it is at present. Of vessels lost at present perhaps nine-tenths are lost upon rocks or on the coast, but of all such how very few there are that would not have been able to keep clear of the land, if they had had a moderate power of steam on board, instead of being de-

pendent upon sails ; and of those that are lost in the open sea, almost the whole are lost through their masts, from which cause of danger, the steamers would be freed.

13th.—All possible improvements in chronometers, and the means of finding the latitude and longitude, would have an effect upon navigation not worth mentioning in comparison of what would be effected by the general use of steam, for there would then be no necessity whatever for ascertaining a vessel's position to a nicety ; in approaching the land it would be a matter of little consequence to her whether the weather was thick or clear, or whether she made the land to windward, or to leeward of her port ; and when she did run into any danger she could just as easily run out of it again ; not that it is impossible for a steamer to be lost, but in nine cases out of ten, a position which renders the loss of a sailing vessel inevitable, would not in the least endanger a vessel without masts but with a moderate steam power.

14th.—In the case of war steamers, a small squadron could carry a large body of troops, as the length of the voyage would be almost certain, and they could not only appear at any moment upon any point of an enemy's coast, but they might proceed direct up any navigable river, and land the whole force, complete and fresh, in the heart of the country, and also proceed up the rivers in support of them after they were landed.

15th.—It is by no means the least important feature in this plan, that those vessels would draw little more than two-thirds of the water, that vessels intended to carry heavy masts and to work to windward must draw, so that they would enter ports, rivers and channels, where at present vessels of two-thirds of their burthen could scarcely enter. Thus many harbours and rivers at present almost useless as ports, would become equal in value to those now containing half as much water again.

It may here be remarked, that in all the above calculations of expence the commander and officers are supposed to be unacquainted with the steam engine, but it is evident that if the system was introduced, they would soon be men as well acquainted with the management of an engine as they are at present with that of the sails, for the former would be as much their business in steamers without sails, as the latter is at present. This would of course reduce the expence materially.

In conclusion it must be remembered that all the calculations in this paper are made upon the present state of the marine steam engine. Taking into consideration that every year adds some improvements, is it too much to expect that by the further reduction in the quantity of fuel required, the advantages may be so decidedly in favour of steam, that sailing vessels will in time, be as few in proportion as steamers are now.

For instance it is well known that the mine engines in Cornwall, are some of them worked with less than 2-lbs. of coal per horse power per hour, which is one-third of the quantity consumed in the best engines at present afloat, and a quarter of what is allowed in the above calculations; and again with respect to the weight of boilers, those used on railroads and making steam sufficient for a 50 horse low pressure engine, weigh only about 6 tons. From what has been thus already accomplished in other branches of steam power, we may fairly conclude that much will yet be done in engines used for marine purposes.

The principal difficulty to be overcome in the introduction of such a new system as this in navigation would be the persuading men to trust themselves at sea without standing masts ; it is well known how difficult it is to lay aside any thing in which men have been accustomed to trust for ages ; the use of masts in the powerful coasting steamers, after so many years have shown that they are of little or no use, is a case in point. A remarkable instance was also seen in the case of the introduction of chain cables ; ships were not trusted at sea without a hempen cable, till very long after they had ceased to be used. But the removal of standing masts is an *essential feature* in the proposed plan for neither can very low steam power be used, if vessels are to encounter the resistance of the wind to masts and rigging, nor can a masted vessel be worked with the small crew proposed.

If a sufficient crew is to be carried to work sails, it alters the whole case, and such an arrangement is not the one proposed. The question is, whether it will not answer to work a vessel by low steam power *instead* of by the winds.

October 1840.

III.—*On the Separation of the Pomegranate as a distinct Natural Order from Myrtaceæ.—By* Robert Wight, M. D., &c.

The most eminent botanists of the present day being divided in opinion as to the propriety or otherwise of separating the Pomegranate as a distinct natural order from Myrtaceæ, I have recently been induced to examine this question, bringing to my aid the lights thrown on carpellary arrangement by my recent investigations of Cucurbitaceæ.

The result of this examination has led me to the conviction, not only that Granateæ is a distinct order, but that the pomegranate, if my views are correct, is, so far as our information yet extends, the most remarkable fruit in the system of plants. But, without further preface, I shall at once proceed with the subject, introducing it by presenting a series of extracts from the leading disputants on either side. The whole controversy turns on a simple question of fact, namely, what is the structure of the ovary and fruit of Punica? To these points therefore I shall, to save room, limit my extracts. The first of these, taking them in chronological order, is from Mr. D. Don's paper, Edin. New Philosop. Journal, for July 1826. The second is from DeCandolle's Prod. 3. p. 3. The third is from Dr. Lindley's Natural System of Botany, ed. 1st, page 64, and repeated in the second edition. The last is from Mr. Arnott's article Botany, Encycl. Brit. ed. 7, page 110, under Myrtaceæ. These extracts, by placing the question before the reader in all its bearings, will enable him at once to judge, how far I have succeeded in setting the question at rest.

" *Bacca* pomiformis, limbo tubulosa dentato calycino, nunc contracto, coronata: *cortex* crassissimus, extùs cuticulâ lævi rubicundâ punctatâ lucidâ vestitus, intus spongioso-carnosus, albus, dein, maturâ baccâ, fissurâ irregulariter rumpens. *Placenta* cortici baccæ substantiâ simillima, at magis carnosa et succulenta-baccam omnino replens, in loculis numerosis polyspermis inæqualibus reticulatim atque interrupte excavata. *Dissepimenta vera* nulla: *spuria* tamen adsunt, quæ e substantiâ placentæ orta, valdè sunt fragilia, et crassitie variâ. Don (l c.)

" The real structure of the fruit of the pomegranate appears to have been overlooked by all authors, I have consulted on the subject, and even the distinguished Gærtner has fallen into error both in his description and figure. It is in reality a fleshy receptacle, formed by the tube of the calyx into a unilocular berry, filled with a spongy placenta, which is hollowed out into a number of irregular cells, in which the seeds are placed ; the dissepiments being nothing more than thin portions of the placenta. If we could conceive the fruit of *Rosa* to be filled up with an interrupted pulpy matter, it would be exactly of the same structure as the pomegranate." Don (l.c.)

" Fructus magnus, sphæricus, calycis limbo subtubulosa coronatus, ejusdem tubo corticatus, indehiscens, diaphragmate horizontali inæqualiter bicameratus ; camerâ superiore 5-9-loculari, camerâ inferiore minore 3-loculari, septis utriusque membranaceis loculos separantibus ; placentæ cameræ superioris carnosæ a parietibus ad centrum

tendentes, in inferiore processus irregulares ab ipso fundo" D. C. (l.c.)

" The fruit of the pomegranate is described by Gærtner and DeCandolle, as being divided into two unequal divisions by a horizontal diaphragm, the upper half of which consists of from 5 to 9 cells, and the lower of 3 ; the cells of both being separated by membranous dissepiments ; the placenta of the upper half proceeding from the back to the centre, and of the lower irregularly from their bottom ; and by Mr. Don as a fleshy receptacle formed by the tube of the calyx into a unilocular berry, filled with a spongy placenta, which is hollowed out into a number of irregular cells. In fact, if a pomegranate is examined, it will be found to agree more or less perfectly with both these descriptions. But it is clear that a fruit as thus described is at variance with all the known laws upon which compound fruits are formed. Nothing, however, is more common than that the primitive construction of fruits is obscured by the additions, or suppressions, or alterations, which its parts undergo during their progress to maturity. Hence it is always desirable to obtain a clear idea of the structure of the ovarium of all fruits which do not obviously agree with the ordinary laws of carpological composition. Now, a section of the ovarium of the pomegranate in various directions, if made about the time of the expansion of the flowers before impregnation takes place, shews that it is in fact composed of two rows of carpella, of which three or four surround the axis, and are placed in the bottom of the tube of the calyx, and a number, varying from five to ten, surround these, and adhere to the upper part of the tube of the calyx. The placentæ of these carpella contract an irregular kind of adhesion with the back and front of their cells, and thus give the position ultimately acquired by the seeds that anomalous appearance which it assumes in the ripe fruit. If this view of the structure of the pomegranate be correct, its peculiarity consists in this, that, in an order the carpella of which occupy but a single row around the axis, it possesses carpella in two rows, the one placed above the other, in consequence of the contraction of the tube of the calyx, from which they arise. Now, there are many instances of a similar anomaly among genera of the same order, and they exist even among species of the same genus. Examples of the latter are, Nicotiana multivalvis and Nolana paradoxa, and of the former Malope among Malvaceæ ; polycarpous Ranunculaceæ as compared with Nigella and polycarpous Rasaceæ as compared with Spiræa. In Prunus I have seen a monstrous flower producing a number of carpella around the central one, and also, in consequence of the situation, upon the calyx above it ; and, finally, in the *Revue Encyclopédi que* (43.762.) a perma-

nent variety of the apple is described, which is exactly to *Pomeæ* what Punica is to *Myrtaceæ*. This plant has regularly 14 styles and 14 cells, arranged in two horizontal parallel planes, namely, 5 in the middle, and 9 on the outside, smaller and nearer the top; a circumstance which is evidently to be explained by the presence of an outer series of carpella, and not upon the extravagant hypothesis of M. Tillette de Clermont, who fancies that it is due to the cohesion of 3 flowers." Lindley (l.c)

"To the Myrteæ we, with Mr. Lindley, unite the Granateæ, because *Punica* or the pomegranate only differs by having its two verticels of carpels developed instead of one, and perhaps in a truly wild state the upper or adventitious one may occasionally disappear. The inner series (or those at the bottom of the fruit) have their placentæ in the axis; but the outer series, forced to the top of the fruit by the contraction of the mouth of the tube of the calyx, having their placentæ in the ovary at the back of the inner carpels, exhibit them in the ripe fruit in a horizontal position on the upper surface of the lower cells." Arnott (l.c.) et Prod. Fl. Peninsulæ, 1, page 327.

Premising that the whole controversy turns on these questions,—1st what is the true structure of a pomegranate? and 2d, whether the difference between it and Myrtus is sufficient to separate these genera as distinct orders?—I shall now proceed to examine these conflicting statements, and endeavour to ascertain on which side the balance preponderates, and whether, indeed, there is not room for an explanation different from any of those yet proposed.

Mr. Don's description of this fruit, on the strength of which he first proposed to remove this genus from Myrtaceæ, the order with which it was previously associated, as a distinct family, appears to me most unphilosophical and altogether untenable. He, as I understand, considers the fruit a one-celled receptacle, the centre of which is filled with a spongy placenta, round the surface of which there are a number of irregular cells occupied by clusters of ovules, but he does not tell us how the central placenta got there, neither does he account for the ovules being attached to the parietes of the cell, and not to the central placenta. His whole description in fact proves that it had been drawn up from inadequate examination, and that he, at the very time he is accusing all authors of overlooking the real structure of the fruit, totally misapprehends it himself, as we shall by and by see.

DeCandolle gives a more correct description of it when he says, that it consists of two chambers, the under 3-celled, the upper from 5 to 9-

celled, with the placentas of the upper cells reaching from the parietes to the centre, while those of the lower division proceed irregularly from the bottom of the fruit. He does not, however, assign this peculiar structure as his principal reason for viewing the order as distinct from Myrtaceæ, but has recourse to others, in my estimation, of minor importance.

Lindley conceives that there are two rows of carpels, three or four of which surround the axis at the bottom, while the remainder surround these, and, occupying the upper part of the fruit, adhere to that part of the tube of the calyx. The placentas of these upper carpels, he conceives, contract an irregular kind of adhesion with the back and front of their cells. The meaning of this is far from being clear to me, but if it means that he considers the placentas of the upper as well as the lower row to proceed from the axis towards the circumference, to which last they contract accidental adhesions, then he takes an erroneous view, and if the examples quoted in illustration support this view, they are not in point as regards the structure of Punica.

Mr. Arnott, like Lindley, views the fruit as consisting of two rows of carpels, an outer and inner, the former of which he thinks may be adventitious. To understand his theory, we must first suppose the tube of the calyx spread out as a flat surface and covered with two circles of carpels, the inner next the axis, and the other occupying a larger circle beyond, that the margin of the calyx then contracts so as to turn the outer series over the inner. According to this supposition, the attachment or base of the placentas of the outer series should be in the circumference, and the apex in the centre, while that of the inner should be in the opposite direction, that is, have the base in the centre and the apex towards the circumference; an explanation which is in accordance with what we find, except in so far as it does not account for the horizontal partition between the two series: nor can I exactly understand on what ground we are warranted in assuming that the outer series is adventitious and the result of cultivation, as it has every where been found so constant in all circumstances. But be that as it may, this theory certainly accounts for the crossing of the placentas in the two rows which we so invariably find, whether correctly or not, cannot be determined, until we get fruit with a single row of carpels, which has not yet been found.

These explanations, which I venture to propose, of rather obscure descriptions, did not occur to myself until after I had formed a new theory of my own, the result of a very careful examination of the ovary in all stages from the earliest, up to the period of impregnation. At these early stages, when the whole flower had not yet attained half an inch in

length, probably a fortnight or more before expansion, I invariably find two rows of carpels, one inferior, of 4 or 5, and one superior of 5, 6 or more. In the lower series the placentas are ranged round the axis, with their base in the centre, and the apex, which is free, towards the circumference. In the upper, the attachment, or base of the placentas, is in the circumference, and the apex, also at first free, directed towards the centre. Between the two rows a diaphragm is always interposed. The apex of the upper placentas is, occasionally, afterwards prolonged and contracts adhesions to the axis.

In the accompanying figures I have attempted to represent these views. As the fruit advances in size considerable derangement of this structure progressively occurs, which is apt to mask and confuse the appearances now described.

Having previously ascertained the occasional existence of inversion in the position of carpels, my first idea was, that such an inversion took place in the upper row. This view, which, equally with the preceding, accounts for the crossing of the placentas, I feel inclined to adhere to, though I confess not without some hesitation, because it implies a complexity of arrangement rarely met with in the inimitably simple and beautiful operations of nature; but I think it as difficult to imagine the nearly equally complex and inconceivable operation of the folding in of one set of carpels over the other, which Drs. Lindley and Arnott's explanation demands: while my explanation has the advantage of at the same time accounting for the double chamber which the ovary presents from its earliest stages, and renders unnecessary the doctrine of an adventitious verticel of carpels, which for the present is mere assumption.

With these explanations, I leave the question of structure to consider the one pending on its determination, viz. whether or not Granateæ ought to be preserved as a distinct order or be re-united to Myrtaceæ?

On this point, so far as the unvarying evidence derived from cultivated plants is entitled to carry weight on a disputed point—and which I presume it must do until we find that evidence invalidated by the examination of others growing in a truly wild state—we must unquestionably, I conceive, adopt the views of those who urge the separation, because the complex structure, above described, being constant here and unknown among the true Myrtaceæ, we have no right, in the total absence of direct confirmatory evidence, to assume, that a part is adventitious, merely because it is at variance with our ideas of what should be, especially while we have, in addition, difference of habit in the formation of

the seed, and their pulpy envelope, in further confirmation of the correctness of these views.

In coming to this conclusion, I do so, mainly on the evidence I have myself adduced: attaching no value to the opinion of Mr. Don, which, being founded, according to his own showing, on most erroneous view of the structure of the fruit, does not merit much consideration.

To the views of DeCandolle more importance must necessarily be attached, as the reasons he assigns are more satisfactory, though I do not think he has attached sufficient value to the very peculiar "economy of the fruit," while he has given too much to others of much less note, such as the want of pellucid dots, the absence of the marginal nerve of the leaves, and the pulpy covering of the seed; thereby throwing into the shade the true essential character of the order, which unquestionably lies in the double row of carpels, with the upper placentas parietal and crossing the lower axillary ones, which, if I have rightly accounted for, constitute this a truly curious and unique fruit; and which, whether or not my theory of its construction be correct, is yet so very different from that of every true Myrtacea, as to leave no doubt of its forming the type of a distinct order.

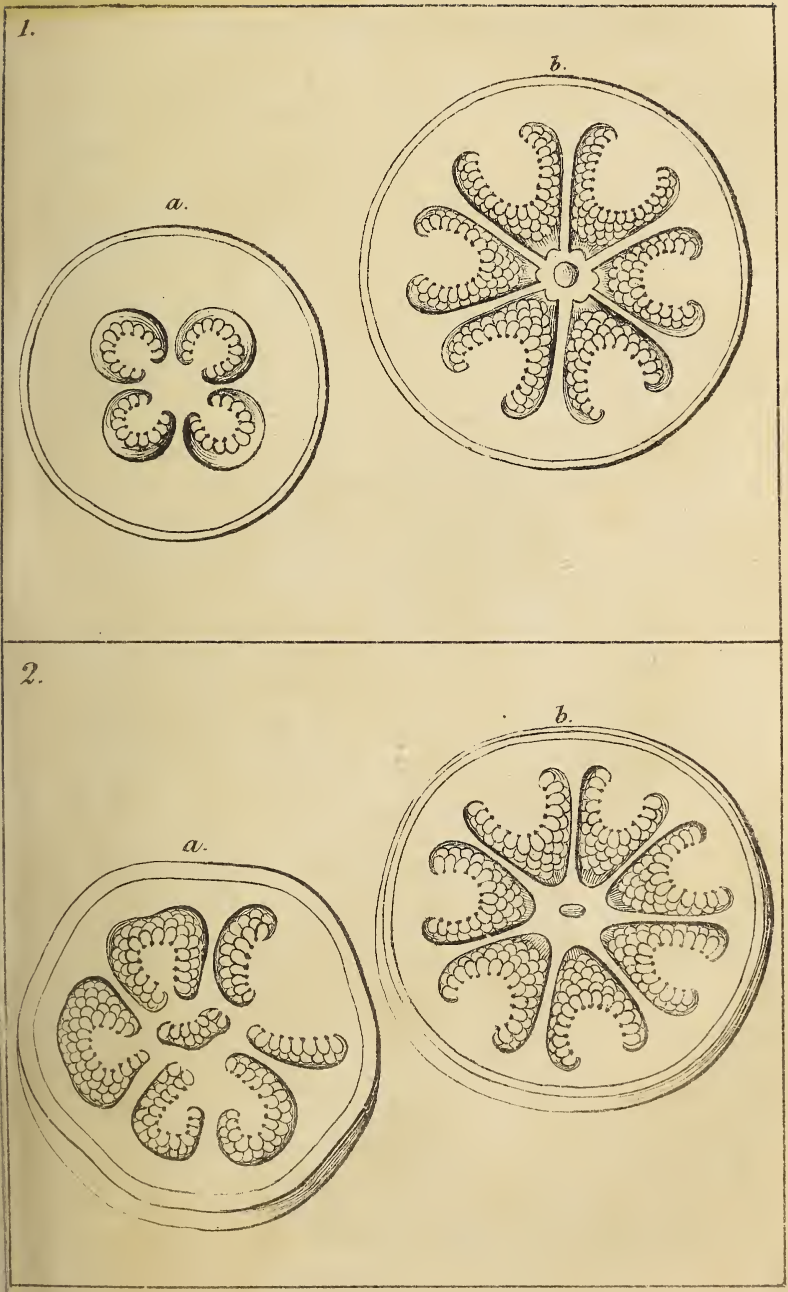
EXPLANATION OF PLATE.

1.—a. Section showing the lower series of carpels in the ovary of the Pomegranate many days before the expansion of the flower.

b. Section showing the upper series of carpels. These two figures are taken from opposite sides of the same slice.

2.—a. Section showing the lower series of carpels in an ovary some days after the expansion of the flower. At this time considerable derangement has taken place apparently caused by the rapid expansion, in a confined space, of the ovules after impregnation.

b. Upper series in the same ovary, and, as in the former instance, taken from the opposite sides of the same slice. Here the derangement so obvious in the lower section has not taken place.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a.
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2.
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b.

BRITISH MUSEUM
NATURAL HISTORY

IV.—*On the Construction and use of Portable Barometers.—By Captain* J. Campbell, *Assistant Surveyor General.*

1.—From some cause, not yet properly investigated, barometers, as hitherto constructed for portability, generally become damaged on the voyage to this country, and even are liable to injury during transport on land in this climate. I consider it likely that the plan on which these instruments are constructed is faulty, and that the expansion of the mercury in those, the tubes of which are closed by a screw, is sufficient to cause the fracture of the tube. It is even probable, when carried in an inverted position, that the expansion of the mercury in the tube and the air in the cistern, which in this position will be of course in the bottom part of it, is sufficient to force out the mercury through the pores of the cover, and that the alternate expansion and contraction of this portion of air, according to the changes of temperature, may be sufficient to force out all the mercury in the cistern, or to leave so little in it, that, on setting up the instrument, there is not sufficient left to cover the aperture of the tube.

2. On examining a damaged mountain barometer, on "Newman's improved portable iron cistern" plan, I consider I have found some reason to suppose that the above remarks may be correct, and as the construction of the instrument is not generally known, I append the following description.

3. The cistern of this instrument is formed of a cylinder of iron $2\frac{1}{2}$ inches long and 1 inch and three-tenths in diameter. The cover of it is a close grained piece of box wood, cemented on to the tube and screwed tightly into the cistern. Through the pores of this piece of wood the air finds a passage to exert its pressure on the surface of the mercury; and, under considerable pressure, the mercury would probably also be forced through the pores. The bottom of the cistern is double, the lower part being about one-fifth of the capacity of the upper. This lower part turns on a centre, by which it is attached firmly to the other piece, and when turned to "not portable," as engraved on the brass case, two holes in each part coincide, so as to open a passage between the two divisions, and when turned to "portable" these passages are tightly closed. In constructing the instrument, the tube having been boiled, it is attached to the cistern by cement, the cistern is then filled full of mercury, and the bottom part is then turned to "portable", which closes the apertures of communication, and leaves the part of the cistern with which the tube is connected *perfectly* full of mercury. By a screw hole the mercury in the movable bottom is then allowed to run nearly all out, and,

the screw being replaced, the instrument is finished. The bottom part is then turned to " not portable," and the instrument is set upright. In this position, the air which was in the movable bottom of course passes up through the two apertures, and the mercury descends into the space the air had occupied, thus leaving a part of the upper cistern empty to allow of the descent of the mercury in the tube. The instrument is then compared with a standard barometer, and the scale adjusted so as to shew the proper height. The height of the column indicated at this time is called the " neutral point." When the instrument is prepared for transport, it is first inverted, by which the mercury again fills the vacuum in the top of the tube, and also fills completely the upper part of the cistern, and the bottom being turned to " portable" all motion of the mercury in the tube is prevented. But the consequence is, that no allowance is made for the expansion of the mercury in the tube, and supposing the instrument packed in London at the temperature of 32°, and that on the voyage it was exposed to a temperature of 140 (which is quite probable), the expansion of the mercury in the tube 32 inches long would amount to more than three-tenths of an inch, and the wooden cover of the cistern being nearly 50 times larger than the tube, this expansion of the mercury would act with an *irresistible* force, multiplied 50 times, to force out the cover, or the mercury into its pores. There can be little doubt that the cover, after being exposed to this enormous pressure, would become loose, after which the expansion of the small quantity of air which would get into the cistern after the instrument was exposed to cold again, would be able to force out more mercury from the cistern, an effect which would go on increasing until the instrument was quite destroyed : or if set upright with the movable bottom part turned to " portable," the weight of the mercury in the top of the tube, would exert a pressure increasing as the barometrical pressure at the place decreased, and most likely quite enough to force out more mercury from the loosened joints. Another defect in the instrument arises from the cover of the cistern being made of wood. In the instrument examined, this has shrunk so much, that it is quite loose, so as to afford a very easy escape to the mercury. This part should have been made also of iron, with a small plug of loose grained wood inserted in it. Another imperfection lays in the scale not being connected with the cistern by a brass rod, which it should have been, by which the uncertain longitudinal expansion of the wood mounting would have been counteracted. A very strong corroboration of the remarks of the late Lieut. Braddock on this last imperfection may be seen in the instrument examined. The scale is 14 inches in length, and is attached at each end

to the wood mounting by a screw. In consequence of the shrinking in the wood between these points, the scale had bowed out, and the person who had used it had therefore removed the screw at the upper end; and it could be easily seen, from the hole of the screw which was worked into a piece of brass no longer coinciding with the hole in the scale, that the wood within the length of this 14 inches had shrunk in length full one-twentieth of an inch, and therefore the whole instrument has decreased in length one-tenth of an inch—yet the scale very absurdly professes to give the height of the mercury to the 500th part of an inch. I am unable to see any advantage in this plan for a portable barometer, and on the contrary have pointed out undeniable disadvantages.

4. The object to be gained in a portable barometer is principally to prevent the column of mercury striking too heavily against the top of the glass tube, which may, I think, be easily gained, by making the cistern wholly of iron; in the bottom an iron screw may be placed, the point of which has a piece of India rubber attached to it, and which being screwed up will close the bottom of the tube. A very fine capillary passage should be worked down the point of this screw, and out laterally, so as to allow of the *gradual* descent of the mercury, in case the instrument should be placed upright, and also of the expansion in the tube. Such an instrument could only be destroyed by inverting it with a jerk after being held upright.

5. Guy Lussac's plan of the syphon barometer is the best portable instrument I am acquainted with, and I consider the instrument here described as constructed for me by Messrs. W. and J. Jones of Holbourn, London, to be the best adapted for use in India.

6. The case is constructed solely of brass, it is 36½ inches long, and is formed of two brass tubes, about seven hundred parts of an inch in thickness, joined together by a short brass cylinder between them, into which they are both screwed, the upper being seven-tenths of an inch in diameter, and the lower nine. The top and bottom are closed with screwed plugs with rings. In the front and back of each of these tubes, a slit, 9 inches long, and a quarter of an inch wide, is worked, through which the glass tube is visible. On the edges of these slits the divisions are laid off upwards and downwards from a central point. On both the upper and lower tubes, two short thin brass cylinders, each ¾ of an inch long, slide freely. On the lower part of the upper of these pieces, on each tube, a milled ring works in a groove, and the upper part of the other cylinder, having an external screw cut on it, works into an internal screw cut in the brass ring, by which on turning round the milled ring, the lower portion of each of these cylinders is raised or lowered about

three-tenth of an inch, so as to allow of an adjustment in this manner to the upper surface of the mercurial column, as seen through the slit. In each of the lower pieces of these sliding cylinders, a portion is cut out ½ an inch long and a ¼ wide. The sides of the notch thus formed coincide with the line of the divisions, and on one of these sides the vernier is cut; the bottom of the lower piece of the sliding cylinder being the bottom of the vernier, and being brought as a tangent to touch the top of the mercury. The back and front part of the bottom of this piece, being both made to apparently touch the mercury, prevent any error from parallax by the uncertain position of the eye in taking the observation.

7. The glass tubes are formed in four parts, the upper is 11 inches long, and at bottom is drawn out into a capillary quill 2 inches long. A piece of tube, of a little larger diameter, and four inches long, is soldered to this tube, above the contraction, so that the capillary quill projects free two inches into the centre of this short piece of tube. To the other end of this short piece is soldered the rest of the tube, which is bent up as usual in syphon barometers, and the recurved end is finished as in Guy Lussac's plan with a small lateral hole, over which a piece of wash leather is tightly bound, or a capillary glass quill 3 inches long is inserted into the end and soldered, and a piece of wash leather is tied over the outer orifice. If the tube is of the latter construction, it is necessary to be careful after setting up the instrument to oscillate the mercury up to the summit of the tube, so as to draw out any small portion of mercury from the quill, which would make the mercurial column stand too high. By the capillary quill in the centre of the tube no portion of air can get into the top, and the tube is in no way affected by any portion of air which may get into the lower part. As thick tubes cannot be soldered together in the above manner, these tubes are necessarily slight, but packing with India rubber, so as to support them closely, for which Messrs. Jones have my directions, they are rendered quite as safe in carriage as any others. The price charged for these instruments by the makers was 7 guineas each, and one very great advantage in them is that fresh tubes can be inserted in a few minutes, which no other kind of portable barometer will admit of.

8. A very great advantage in syphon barometers is that the capillary action of the tubes is neutralized, which, in India, where but few opportunities of comparing barometers occur, is not to be lightly regarded. Experiments have not yet decided what the true capillary action in barometer tubes really is, and in Daniel's Essays it is plainly shown that capillary action in the same tube differs according to circumstances.

9. Daniel has pointed out that many barometers are made and sold in London, the tubes of which are not *boiled*, and the divisions are laid off by comparison with other instruments. This is also often fraudulently done with instruments for exportation, and when they are made with close cisterns, this fraud is difficult to detect, but in syphon barometers is easily discovered, because the mercury in an unboiled tube will not stand within an inch nearly of its proper altitude, and if the divisions have been laid off from the ends of the mercurial column instead of from a central point, the distance between the divisions, as numbered on the top and bottom parts of the instrument, will not be found to agree. Thus between 7 on the lower part, and 7 on the upper part, should be 14 inches exactly; if it is less, then the instrument has been improperly made.

10. Those who have sufficient mechanical skill and ingenuity to boil the tubes themselves, may provide themselves with instruments like the syphons above described at a much lower price by ordering the brass cases without tubes, and a stock of empty tubes to be sent; for which Messrs. Jones charge only 8 shillings each. These tubes are sent out in two pieces; the recurved part being separated, and to be attached at the lamp. But the method by which I prefer to fit them up, is the following. I bend the end of the long part at right angles, and then cut it off close to the side, so that a piece of 2 or 3 tenths of an inch projects; I then fill the tube with water, and then with mercury, and free the upper part from air, as hereafter described. I then heat the closed end gradually over a chauffer, and make all the moisture simmer up to the open end, carrying the tube gradually across the fire. The closed end is then again heated (the tube being held at an angle of 20 degrees with the horizon), until the mercury first becomes speckled and then forms large bubbles, which by making the tubes revolve, are carried gradually and spirally towards the open end, collecting all the smaller bubbles in their way. The mercury must never be allowed to boil and snap, for if this is allowed, minute portions of gas, hardly visible when cold, are carried down towards the closed end, and cannot be removed except as directed. The gas I consider to be probably hydrogen, evolved from the decomposition of minute organic substances in the tube. I find by frequent experiment that filling the tube first with water is the best method to get all the air out, instead of carefully drying the tube as generally directed. The tube being properly boiled, the part for the recurved end is to be sealed at the lamp, and the end finished as customary by blowing, and then the rounded end of a rod of glass being applied to the side of the tube, ½ an inch from the sealed end, and this being pulled when the

tube is softened, a little cone is easily pulled out. The end of this is to be broken off, and the hole thus made opened and finished, to receive the bent end of the long tube. The two tubes are then tied strongly together with thread, and small pieces of cork between, and then the junction between the tubes is to be made good with sealing wax, and when cold, an inch of mercury being poured into the recurved end, the tube is finished. Two tubes thus constructed, I have found by hourly observations for many days, never to differ one-hundredth part of an inch.

11. But the best and most portable kind of barometer for India, is with tubes to be filled *wet*, they can be carried empty, and therefore are not liable to accident, and when wanted can be filled in five minutes. The late Mr. James Prinsep, in the Journal of the Asiatic Society of Bengal, has pointed out the advantage of this plan, and by frequent experiment, and during long continued series of observations, I find tubes thus filled are perfectly comparable together, and also with boiled tubes; the only precaution necessary is to make the column of mercury touch *the top of the tube* by inclining the instrument about a minute before each observation. To fill tubes thus, I use a little funnel of iron with a small point and capillary tube attached to it. Having filled the tube with mercury, it is to be set upright in some mercury in a cup, on which half an inch of distilled or rain or any clean water has been poured. By raising the end of the tube a little above the mercury, all the mercury in the tube will descend, and its place be supplied with water. The tube is to be then refilled with mercury, and again set up in the cup, and again raised a little, so as to let one inch of water only ascend to the top of the tube. A quantity of air bubbles extracted from the water will ascend into the vacuum, and the column of mercury is to be oscillated to assist their escape. The tube is then to be inclined until it is filled, and the end being closed with the finger, it is to be removed from the cup and inverted. The bubbles of air which had collected in the top of the tube will now ascend to the open end, as also the water which had been exposed in the vacuum. Mercury is then to be poured in until the water has reached the open end, and the tube is then to be set up again in the mercury, and while upright the end is to be closed by the finger, and inverted, by which the rest of the moisture in the bottom of the tube will be exposed to the vacuum; after which the tube is to be again immersed in the mercury in the cup, the vacuum being still preserved with the finger, which is then to be gradually removed. The tube is now to be gradually and very gently inclined until the water touches the top, and it is then to be removed and in-

verted, when any bubbles of air in the top will ascend to the open end, the water in the tube assisting its escape upwards. The tube is then to be completely filled with mercury, and allowed to stand five minutes, for the mercury to settle down. On setting it up now in the mercury, if the operation has been properly done, it will be found that the mercury will not fall in the tube, unless the tube is jarred heavily against the bottom of the cup, shewing thereby that the air has been completely extracted. Even when dirty, the tubes answer nearly as well when thus filled. Quilled tubes as before described may be thus used, and they are easier freed from air than the common plain tubes. As they are not required to be heated it is unnecessary to solder the parts together, and the upper quilled part may be made only six inches in length, and the lower portion may be joined to the upper by a sealing wax joint. When such tubes are required for high altitudes where the mercurial column is less than 24 inches in length, the lower portion of the tube may be shortened, by cracking off a piece, as it is better to keep the top part as short as possible, it being then most easily freed of air.

12. The instrument which I prefer for measuring the altitude of the mercury is very portable and simple, and Messrs. Jones have the minute directions necessary for making it. The following is a general description of it. It is formed of a solid piece of dry mahogany, 39 inches long, 2 inches wide, and 1½ inches thick—along the centre to within 2 inches of each end, a groove three-quarter inch broad and the same in depth is hollowed out. Across the bottom of this groove a piece of plate glass 1½ inches wide is let in level with the face of the piece of wood. This glass forms the cistern for the bottom of the tube, and allows the surface of the mercury to be distinctly seen. The tube is laid in this groove loosely with cotton, and a flat piece of brass, which turns on a pivot across the top of the groove, keeps it in its place. The wood on the right side of the groove is cut away to allow a brass bar, six-tenth inch wide, and quarter inch thick, and 32 inches long, to be fitted in there. This bar is divided into inches from a standard scale, at a noted temperature, and serves to measure the length of the column. It is not fixed, but can be moved up and down about ¼ inch by an adjusting screw, to allow an ivory point which it bears on its lower end to be brought into exact contact with the surface of the mercury in the cistern. The vernier slides on the upper part of this bar, and has an adjusting screw also. The tongue attached to the vernier turns on a hinge joint to give room for putting in the tube. A cover, formed of a piece of mahogany of the same length and breadth, and ½ inch thick, is

attached to the left side of the instrument by three hinges, and closes by 3 hooks and a small lock and key. Hollows cut out in the cover admit the heads of the adjusting screws, and in it are also imbedded a small delicate thermometer, a hook with a conical screw, to screw into a tree or post, to hang the instrument on, and an ivory plate with the aqueous tension in inches engraved on it from 32° to 120° of Fahrenheits. A brass swivel ring attached to the top screw serves to hang the instrument up by.

13. To take an observation the tube is filled as directed above, and the case being held by an assistant to an angle of 45° with the lower end over a plate, or handkerchief on the ground, the cistern is filled with mercury until it runs over. In this the end of the tube is immersed while closed with the finger, and it is then laid in the groove, the securing piece of brass turned down, and the instrument held vertical, the surplus mercury in the cistern running over into the plate or handkerchief. The bar is then screwed up as far as it will move, and some of the mercury in the cistern, is allowed to run out, by a little channel through the wood, which is stopped by an ivory pin ; until the end of the ivory pin attached to the bar becomes visible (which projects about six-tenth inches below the edge of the glass plate). The point is then brought into exact contact with the mercury in the cistern by the adjusting screw, and the height read off by the vernier. As tubes ½ an inch diameter in the upper part, can be used in this manner, the effect of capillary attraction is avoided, and the length of the mercurial column, added to the aqueous tension for the temperature, gives the correct pressure, with a degree of precision never exceeded in portable barometers, and comparable even with the best standard instruments.

14. In publishing barometrical observations, whether for altitudes or for a series of meteorological observations, observers should be always careful to describe their instruments, and to give certain evidence of their being in good order. For want of this many series of observations recorded, are hardly worth the trouble of making them ; and it must be recollected, that having compared a barometer at one time with a standard instrument, is no proof of its being in good order at another. It might seem to some that the last remark was somewhat gratuitous, but in turning over some recorded meteorological observations, I find a gentleman remarking that his barometer "had been compared with Mr Prinsep's standards, and had proved correct, and that it had *since* been *emptied, and the mercury purified*"—which is almost as much as to say that his observations were worth nothing, although Sir John Herschel in remarking on them was too polite to say so. In general

a single tube barometer is useless for nice observations, unless it has been compared with another, even if it is in good order, for the capillary action in the tube *can never be valued* unless by comparison with a barometer which can be depended on. The double syphon tubes I have above remarked are free from this defect, but whatever the construction may be, the mercury in a good boiled tube must be free from specks or cloudiness throughout its whole length; and it must *jar* against the top of the tube (not *bump*), as a bar of steel might be supposed to do.

15. Since the above was written, I have had the opportunity of examining another of Newman's barometers, like that described in para. 3, and I found the lid or cover of the cistern so shrunk and loose, that nearly all the mercury had escaped, and also that the tube had been attached to the cover by glue and tow, which, in the damp weather in this climate, had been softened so much, that the mercury had been forced completely through the joint. As there are many of these instruments in India, the following directions regarding them may be useful.

16. Whenever any mercury has been found to have escaped into the case of the instrument, it may be generally considered as certain, that it has become useless until put again into order, and it should in consequence be carefully kept with the cistern upwards, because if set upright, some air might get into the tube, and render necessary the trouble of reboiling the tube. The brass ring at the bottom of these instruments has 6 brass screws in it; the three nearest the wood attach the ring to the wood, the lower three screws are screwed into the wooden lid of the cistern. In the lower piece of brass by which the bottom of the cistern is turned, there are two iron screws, which open into the cavity of the cistern; care must be therefore taken that they are never taken out except when necessary to take the instrument to pieces. The three brass screws which hold the cover of the cistern being removed, the part of the cistern which is movable being pulled, the cistern and tube will come out easily, but great care must be taken not to turn it round in the least, which would snap off the little thermometer. To put a barometer of this kind in order, if any air has got into the tube, the first thing to do, will be to ascertain if the lid of the cistern is tight. The two iron screws in the movable bottom piece being removed, the brass cap may be pulled off easily, and the cistern and tube, can be filled with mercury through the holes. The cistern being quite full, the tube is to be held downwards, and the bottom of the cistern turned round a quarter turn. The tube is then set up in an erect position, and on jerking it slightly up and down, if the lid of the cistern is loose, the mercury will

spurt out in radiating streams, all round the juncture with the cistern. To remove the cistern, a small iron screw in the edge of it must be sought for and removed, and it can then be screwed off the cover. To remove the cover of the cistern from the tube, it must be soaked for a day or two in water at 140 deg. Farhenheit (hotter would break the thermometer), which will soften the glue, and the tube and thermometer must both be pulled out. The interior of the tube must then be washed quite clean by filling it with distilled water, and emptying it again several times. Generally a little dust of black oxide of mercury will be found in it, which must be removed by dropping some nitric acid into it, and washing out again with water. The tube is then to be filled wet with mercury, and freed from air, as directed in para 11, and then boiled. To cement the cover of the cistern on to the tube again, both the tube and the cover being made hot, some sealing wax is to be applied around the tube, and the cover is to be twisted on, while the wax is still soft. The cistern is to be cemented also on to the cover, by heating it strongly over a charcoal fire until it is hot enough to melt sealing wax, and some wax softened in the candle being applied all round inside the screw, the cistern being held by a thick cloth is to be quickly screwed again on to the cover. When all is cold, the hole for the thermometer is to be closed by a piece of soft wood, and the cistern being filled with mercury through the two screw holes, the bottom is to be turned, and the surplus mercury in the bottom is to be allowed to run out. The screws having been inserted, the bottom is to be turned again until the mark on the two pieces shews that the openings coincide, and the tube is to be held upright. The next thing is to insert the thermometer, which is now to be put into its place and cemented with some putty made by rubbing chalk fine with wood oil, which will dry in a couple of days. But as the thermometer is of no use, as it will not shew the temperature of the mercury in the tube, where all the hottest mercury of course ascends, it is better to remove it altogether, and to stop the hole tightly with a deal peg. A thermometer attached as in these instruments, is the more inconvenient, because very liable to be broken, and then of course might endanger the whole instrument by letting the mercury out of the cistern. To finish the barometer, nothing more is afterwards necessary but to adjust to its old neutral point, by comparison with a good barometer, by adding or removing a little of the mercury in the cistern by the screw holes.

V.—*Account of the Basava Puran;—the principal Book used as a religious Code by the Jangams.—By* C. P. Brown, *Esq.*

The description of the Jangams, given in a former essay, may shew how far these Vira Saivas differ in their creed from the other Hindus. To render the view of their state more complete, a sketch of their popular literature may be advantageous. Legendary lore is puerile enough in all countries; and is not worse in India than that which prevailed in Europe, before the invention of printing. That of the Jangams deserves notice, because forming the creed of a large body of Hindus, who venerate the Basava Puran as sincerely as Bramins do the Ramayan.

The *Puran* or legend of Basava was originally composed in the Telugu language by Palacuriki Somanatha, who likewise translated the *Pandit Aradhya Charitra* from the Carnataca language. This poet lived in the days of Pratapa Deva Rayalu, also called Praudha Rayalu, who appears to have ruled the Telugu country from A. D. 1456 to 1477.* That the poet was cotemporary with this prince is stated in the introduction to the modernized (padya metre) version of the Puran, written by Piduparti Somaia.

That introduction further states that the "Charitra" was versified (written in padyams) by Sri Natha, the well known poet who translated the Naishadham into Telugu.† Indeed the antiquated style in which the Puran and Charitra were originally composed, is (though still extremely popular) so rude and inelegant that modern poets have re-written these works, as Dryden and Pope have remodelled the poems of Chaucer and Donne.

After Somaia had translated the Puran into *padyams*, he proceeded to translate the Lila from Carnataca verse into Telugu dwipada. His uncle Basavaya had already written a *padya* version of the Lila; as also of the *Dixa Bodha*, the *Pilla Nayanar Catha* and the *Bramhottara Khandam*. None of these works equal in beauty of style the *Puran* and *Lila* in the *modern* version, written (perhaps about A. D. 1600) by Somaia. Hindus are always apt to give a fictitious antiquity to their favourite authors: and late enquiries have shewn me that the dates mentioned in a former essay require correction.

Some of the more popular legends are contained in books which are con-

* See the chronological series of kings, framed by Col. Mackenzie, and printed in Mr. Campbell's Telugu Grammar.—See also note at end of this article.

† I have not succeeded in obtaining Sri Natha's version: but have in my possession all the other volumes here named.

sidered *Purva Saiva* or braminical; such as the story of Bhallana, that of "Chennappa the savage," and a few others; which are given not only in the Basava Puran but likewise in the *Sri Calahasti Mahatmyam*, in the *Vaijayanti Vilasam*, the *Vira Bhadra Vijayam*, the *Raja Sekhara Charitra*, and some other Canarese and Telugu books, not written by Jangams but by Bramins; and accordingly dedicated not to Basava but to Ganesa or Rama.

These legends, again, are distinct from those (now wholly obsolete) which are given in the Siva Puran and Linga Puran: of these a summary may be seen in the preface to Professor Wilson's translation of the Vishnu Puran. Here, as also in his "Two Lectures" (lately re-printed at Madras*), the learned professor points out that "the wise look upon "the outward emblem as nothing; and contemplate in their minds the "invisible inscrutable type; which is Siva himself. Whatever may have "been the origin of this form of worship in India, the notions upon "which it was founded, according to the impure fancies of European "writers are not to be traced in even the Saiva Puranas."

The *Siddhānta Sékharam*, the *Siva Siddhanta Tantram*, and the *Suprabhéd Agamam* do indeed describe the lingam; but these are *braminical* treatises of modern days, written in Sanscrit. In the *Tantras*, of which an outline may be seen in Professor Wilson's Two Lectures (as also in my former essay), there is not the slightest allusion to the lingam. In the books now to be described, all the legends inculcate devotion to this image of Siva: but regarding the image, or its origin, there is not a single syllable.

The *Purva Saiva* being the *ancient* or braminical creed, offers homage to the image placed in a pagoda or in any sacred situation. The Jangama or *Vira Saiva* is the modern anti-braminical creed,† wherein each individual wears the image. The ancient form directs pilgrimage, penance and sacrifice: the modern substitutes (Guru, Linga, Jangam) devotion to the teacher, adoration of the image, and benevolence to the fellow worshipper. The older form admits of caste, and considers Bramins as sacred. The modern rejects caste, and certainly teaches no veneration for Bramins. In the modern creed every homage is paid to *Basava*, and paid exclusively to him as *Siva*: paying no regard to Parvati, to Ganésa, to Nandi, or any other attendant on Siva: in the older or braminical system (such as is taught in the Calahasti Mahatmyam

* On sale at the Athenæum Library.

† Opposing the braminical superstitions as vehemently as the *Wahabi* creed opposes the older Musulman sects.

and other books named with it) the name of Basava is never mentioned.

The Basava Puran is in seven books, containing (in the original Telugu dwipada) 12,700 lines; it is an evident imitation, in some points, of the braminical puranas; for instance, the introduction declares that to pronounce the three syllables *Ba-sa-va*, and the syllables *Gu-ru*, is a means of obtaining heaven: and that faith (bhacti) is the great foundation of good. The book purports to be a series of legends regarding various devotees (bhactulu) or zealots who attained *faith;* and details the miracles performed by these "worthies." These (in imitation of the braminical mode) are narrated by the god Siva to his wife Parvati and the sage Narada. The book opens with homage paid by Siva to Basava, who is declared to be an incarnation of Nandi (the Apis or sacred bull): and a few of the latter legends are concerning this confessor (Guru) Basavesa, closing with his death; but the greater number of the stories have nothing to do with Basava, and merely describe the devotion of various saints, who lived in ages previous to his birth. These are introduced as being narrated by Basava, or in his presence. The first book describes Basava's parentage and birth as given in the former essay; and then gives the following details.

In his eighth year his supposed father, being a Bramin, wished to invest him as usual with the braminical thread: appointing him a (guru) confessor or teacher. But Basava replied the great Siva is my teacher, and I desire no other. The father tried to persuade him that the *Bramhachari* state, into which this rite introduces children is itself emblematic of Siva. These words greatly offended Basava, who replied "you "speak of ordinary braminism and faith (bhacti), as if they were one and "the same: whereas the *yajna* rites declare bramanism and faith to be "quite distinct. There is no specific form of God as a visible shape: "he is dead in his works who believes that the deity can dwell in a specific form. None can attain eternal happiness unless he meditates on "the (lingam) image, using the six-syllabled spell (Om Namasivaya) "with adoration, and the rosary (rudrāxa) and ashes. Further, divine "bliss (linga-para-saukhyam) has not been expounded even in the "Vedas. Some assert that a religious profession (brāmhanyam) and "faith (bhacti) and spiritual intelligence (darsanam) are all one; but "profession exists merely in the homage paid to gods, &c. and he who "thus is tied to works has not faith. There is a wide distinction be-"tween profession (āchāram) and faith. Faith in the god is the hon-"ourable wife: whereas profession is the (jāra-strī) harlot. Consider "that Brahmins, when invested with the thread commence the rite with

" the adoration of (Nandi) the sacred bull: then why should they de-" part from faith in Siva? surely faith in Siva is our highest object.

" Again: the ties between our parents and ourselves are mere de-" lusion, I will therefore depart from you," &c. &c. Basava then leaves his father's house accompanied (as formerly described) by his sister Nagamāmba; they go to the house of his father's brother, whose daughter Gangāmba he marries. Basava then departs with his wife and sister to *Sangameswara* the abode of his patron god; while offering his prayers here the god Siva appeared to him, embraced him, and stood before him with joined hands; lauding him, and encouraging him to continue steadfast in the faith: and declaring that even an enemy who adores the image, is to be regarded as a friend: he desires Basava to shun all intercourse with such as adore not the image. He further said " Look upon every Jangam as being verily myself."

The Second Book describes the reign of Bizzala, king of Calyanam, whose minister was Basava's uncle: on whose death Basava was made minister; he accepts office on the condition that the king will relinquish the Jaina creed, and become a worshipper of Siva. Basava now devotes himself to hospitality to the Saivites: and washes the feet of his guests.

He appears to have at this time contemplated making some innovations in the religion. He having declined the braminical initiation, the legend declares that at the time of his birth, the god Siva himself descended and breathed the spell (*Namasivaya*; see former essay) in his ear. In other words he framed or adopted the formula for himself, and now communicated it to his nephew Chenna Basavana: this was the son of his sister Nagamma: but here is no mention of his other sister Padmāvati, whom the Jainas say Bizzala took to wife (see Mr. Elliot's remarks, in this Journal, Jan. 1838, p. 212). The legend here asserts that Chenna Basava is a secondary form of Basava himself: the teacher and the pupil being one.

Basava now receives a visit from Allama Prabhu, of whom a short account has already been given in the former essay. Basava adores him as being Siva himself; and Allama is described as bearing the image in his hand. Allama probably is a fictitious personage: he is described as being one with Basava: but from the circumstances we may conclude that at this period Basava determined on wearing the image. For he is not stated to have already bestowed it on his wife nor on Chenna Basava. At his birth indeed, Siva is stated to have himself descended and placed the image on the neck of Basava: but we cannot suppose that being the child of a Brahmin he was permitted to deviate from the fixed dress of the caste.

Here also we first find the mention of *Māhēswarās*, that is, *Jangams* ; who are introduced as a sect already known. But this style probably is used merely to avoid the idea of innovation, for Basava declares repeatedly that all who are devout adorers of Siva are his brethren. And throughout this book we find him lavishing his bounty and his worship on pariars or others who are faithful worshippers of Siva. And it is evident that very few of these are Jangams.

Then follows a discourse intended to prove that faith (bhacti) is all in all. That this is the one boon to be sought ; and that faith makes the (bhacti) adorer equal to the deity. At the close of this conversation Allama blesses Basava, to free him from the power of sin. He then is "resolved into the image" (ling-aikyam), which here is interpreted that he vanished ; but this phrase is elsewhere used to denote death.

Basava then devoted himself to mystic abstraction (Yōga-sastram), and continued his bounteous treatment of the Jangams, "gradually being more and more absorbed in the image as camphor is absorbed by fire."

The next legend describes some robbers who gained access to Basava by wearing on their necks beans which they feigned were (lingams) images. On examination the beans are found to be changed into images. On another occasion he converts a heap of corn into pearls.

Many miracles are related regarding other saints : and some are narrated by Basava himself.

In the Third book Basava distributes in charity the treasures of his master the king. But the treasury is still as full as ever. This introduces another story, wherein a minister who had embezzled money given him to purchase horses, collects some foxes and turns them into steeds. In the next legend one of the Jangams requests Basava to give him a silk dress then worn by his wife Gangamba. She is accordingly desired to strip it off ; and does so ; but in the usual mode it is merely a long sheet, and as fast as she unrolls it more and richer dresses appear under it. The Jangam then cuts off as much as he requires. This is a mere imitation of a story in the second book of the Mahabharat, wherein Draupadi is thus miraculously clothed.

The next set of legends is regarding the (mudha bhact), or *silly saints* —whose feats certainly rival those of the simpletons (ahmaq) described in the Musulman pious legends. These idiot monks, who have bid farewell to common sense always receive peculiar honour among Hindus of all creeds. Several of them are called Minda-Jangams or libertines (as mentioned in the former essay); and absolutely do not know right from wrong. This exalts their merit ; as the force of their faith atones for every other deficiency.

One of these is a pious woman who ponders how it should happen that Siva should have every relation excepting a mother.* She reflected on the grief she suffered at the loss of her own mother; and, imagining it might comfort him, she longed and prayed to become his mother. She thereupon adopts a boy; but, to try her faith he occasionally abstains† from the breast as a fast. She imagines the boy to be unwell, and as he will not tell what ails him, she is about to knock her brains out (as usual in these fables) when he bursts out in divine form as Siva: and offers to grant her every wish. She makes no request and he bestows on her (sayujiam) eternal happiness: and she is now worshipped as saint Ammavva: having been a mother (amma) to Siva.

A man and his wife who daily offered boiled milk to Siva leave home, directing their daughter to attend the god daily. She one day put the milk before him, and bowed to him as she left him to drink. On her return, she finds he had not drunk it. She begs to know what had offended him: as he remains silent she offers (as usual) to knock her head against the wall; but the god took pity on her and drank the milk. This he continued to do daily until it happened that on coming out she met her parents who asked her for the milk in the vessel. She alleged that the idol had drunk it. This they disbelieved as he did not eat what *they* offered. They therefore took the girl to the image to repeat the story to him. She bowed to the figure who opened his bosom; she entered and the marble closed again. Her father caught her by the hair; which therefore did not enter, and still continues to grow! so that they keep it cropped.‡ Could you desire proof more complete of any miracle?

The next legends are yet more marvellous: but they certainly have this negative merit, that they are free from the foulness of the braminical legends, and we find none of the curses therein inflicted, as absurd as they are cruel.

Some of the tales are merely ludicrous. Thus one of these simpletons sees a statue of Siva dancing. He imagines the god is contorted with rheumatism. The story ends as usual by the god carrying his worshipper to (Cailas) Olympus.

* Compare the Legend of Saint Kentigern, as narrated in the second volume of Southey's *Sir Thomas More; or, Colloquies on the Progress and Prospects of Society.* There we even find the story of a fox or wolf used in lieu of a horse.

† Like Saint Nicholas, the patron of thieves, who is noticed at a subsequent page. When an infant at the breast he fasted on Wednesdays and Fridays.

‡ There is a similar story regarding St. Francis. Compare also Napier's Lights and Shades of Military Life, 1840, vol. 2. p. 87, the story of a crucifix, the nails of which they are obliged to cut from time to time.

The next legend is that of "Cannappa the (boya) savage." This story is remarkably popular; it is narrated in various books: and many Hindus at this day are named after this worthy. In the *Sri Calahasti Mahatmyam* the story is given in great detail, but may be summed up briefly. Cannappa (who is one of the *silly saints*) is a forester, who in a dream beholds Siva in the form of a hermit: and is directed to plunge into the forest to seek the god. He next day pursues a wild hog into the wood; where it vanishes and he finds an image of the lingam. Here the god appears to him: the lad recognizing him, invites the god home. The god was silent, and Cannappa imagined this might be the effect of hunger: so he went to bring him venison. Another story is here introduced to shew how the giants turned themselves into wild animals, in the hope that being slain by the blessed hand of Cannappa they should obtain (moxam) heaven. Cannappa now daily brought flesh of wild hogs and deer with which he fed the god: but a Bramin hermit who lived near the spot was offended that Cannapa, being a pariar or outcast should thus gain the favour of Siva, while he himself daily exercised an unprofitable devotion and offered fruits and milk to the image. Here the Bramin introduces the following story. Once upon a time, a devout spider* built her web so as to shade the image; which a devout but jealous elephant tore down and daily bathed the god: which he supposed to be a more acceptable homage: but the spider became a snake and got into his trunk and killed him. Now I, a weak Bramin must thus contrive by cunning to kill this brawny forester. While he thus plotted, the god determined to put the forester's faith to proof. There was as usual a single eye painted on the image. From this eye Cannappa perceived tears were flowing: which he wiped away with his shoe; and then filled his mouth with water which he spirted over the image, which now poured forth a stream of tears. He begged to know what was the matter, *whether the god was in want of food for his wife and children.* Perhaps, said he, you want another eye: if so take one of mine! so saying he pulled out one eye and presented it: but the image still wept: so he pulled out his other eye. Whereupon the god appeared in his true form and restored his eyes.†

The poet now proceeds to extol this saint, declaring that *to be touched by the spittle, and the shoe of this saint was no small honour to Siva.*

* In this legend Sri is asserted to be a Sanscrit word for a spider; a meaning found in no lexicon.

† Compare the legend of Saint *Lucia* at *Naples*, who in like manner tore out her eyes, and had them restored.

And as a satisfactory proof of this story he refers us to the temple at Calahasti, where the image of Cannappa stands facing the image of Siva. There they *first make offerings to the saint* and then *give the leavings* to Siva: they *rinse the mouth of the saint*, and then present this as *holy water* to the god!

This concludes the eight legends of the "childish devotees;" and they are not represented as followers of Basava, who was born in a later age.

The *Sri Calahasti* legend (a separate poem in four books, translated from Tamil) gives this story with the additions that the *spider*, *snake*, and *elephant* (*sri*—and *cala*—and *hasti*) mentioned in this story were adopted by Siva as his devout servants.

The next legend is remarkably popular, and has furnished the theme of several poems. It is the Legend of Sri Sailam, a pagoda on the river Krishna in Curnool: described by Colonel Mackenzie in the 5th vol. of the Asiatic Researches.

A baron named Sacal Esa Madiraz ruled the town of Nambi: he was a great musician, and devoted his talents to the praise of Siva. Paying a visit to *Mallarusu*, a saint who lived at Sri Sailam, he admired that sacred hill: and particularly the *quaking* or *dancing* hillocks: [here is given a long description of Sri Sailam]. It is here stated that Mallarusu was in fact Mallic Arjuna: a personification of Iswara: and to try the faith of his visitor, the god assumed a strange shape, wherein neither his head nor his feet were visible. The pious Madiraz adored him as incomprehensible. The god was well pleased and brought him into his temple where he invested him with the *image*, and told him that as long as he dwelt on earth he must be subject to the (carma canda) law of works. But Madiraz refused to return to earth, and thereupon the god caused a *tumma* tree to spring from the soil, and under it he directed him to dwell. While he lodged there the god again approached him in the guise of a herdsman, and began to hew down the bough that gave him shade, while he sat at his devotions. Madiraz was angry and forbade him to commit such a sin. The swain replied, thy being angry is a sin, for he who gives way to anger is a sinner. If this annoys you, you may go and seat yourself elsewhere. Have you never heard the adage of the flood, at which a bear came swimming down the stream? a man thought it was a sheep, and in attempting to catch it, he was seized by the bear. Thus you sit here in the hope of vanquishing (maya) the earthly passions, and are yourself within their power, as the man was seized by the bear.

Madiraz, however, persisted in reviling him: while he replied by preaching patience: at last the god blazed forth undisguised. Thereupon Madiraz entreats to know how eternal happiness was to be attained: and is answered that he must again descend to earth; that at present there was on earth the great saint Basava; and, said he, go and listen to his preaching, and I will shortly summon thee to this place. Go now to the city of Calyanam, where thou shalt find Basava.

On hearing these words the saint saluted the god, and the next moment found himself at Calyanam: where Basava had by a dream been warned of his approach and received him with honour. This closes the third book.

The fourth book contains the life of a celebrated saint named Madirāla Māçaiia, who was a washerman by trade, and one of Basava's earliest proselytes. He performs great miracles; a touch of his hand slays an elephant; and a second touch revives him. This man and other devotees lay themselves under a vow to cherish or aid the Jangams in some specific mode, such as washing, making clothes or shoes, &c. for them. A variety of such stories are here inserted as being related by Maçaya to Basava. One saint receives a sack of corn from a woman: at his touch they vanish, and at the same moment all the wealth of the sender disappears; this being intended as a punishment for her feeling pride, at making so liberal a donation. Another saint is gifted with Siva's eye (as destructive as that of the *caliph Vathek*), and entering a Vishnu temple, he *consumes* the luckless *statue* of the god! Another devotee named Chiri Tondan Ambi is extolled as having, with his wife, hospitably received Siva (disguised as a Jangam) and at his desire *to be feasted on human flesh*, he and his wife *roast their son* for dinner. On sitting down to table the god desires them to call their child to dinner. On being called the boy re-appears alive.* Hereupon the god shines forth and carries the whole party home with him to Cailasa.

It is believed that this Tondan Ambi was in this manner carried seven times to Cailasa from Canchi: and is to repeat the journey once more at some future period.

The next legends are equally wild. Narasinga Nayanar was king of the Chola country: his wife one day went to worship at the pagoda, and happened to smell to one of the flowers, which were to be presented to the god: whereupon the priest cut her nose off. Her husband ap-

* Saint Servan performed a similar miracle on a pig: as is narrated in the life of Saint Kentigern.

proved and cut her hands off. Whereupon Siva blazed forth, restored his wife her limbs, and carried the pair to Cailas.

There are several stories to show how Siva was born in various places as the son of various devout women. This appears to be a mode of stating that their sons were pious men.

Several of these saints vitiate their sacrifices by a feeling of pride: whereupon they are punished in various modes.

The next story is regarding Miru Mindu Nainar whose faith exalted him so greatly that Siva (by the name Vālmīk-esa) became his servant; nay his slave, and pander. The other devotees hereupon curse both the god and his pet as equally infamous. " At these words the god was so " frightened that he fled and took his pet with him: they stole round " the idol, and passing under its front they ran away into the jungle." Siva's follower *Nandi* expressed his wonder that a god should suffer such distress: but Siva replies, " I and my followers are one: nor can I be free from grief while they suffer. Indeed on a former occasion, when a devout woman was ordered by the king to produce a militia man, as the fee on her land, I myself went and served* as a soldier furnished by her." This " shews the wonderful power of faith: the good deeds of a former birth would never suffice to obtain such a boon. Wert not thou proud, O Nandi thou wouldst attain *oneness* with me."

Here Basava is informed that Nandi ultimately became thoroughly humble; and this gained him the honour of canonization.

" And next to faith, charity is the great means: for example this Nambi after bestowing all he had on the poor, proposed even to bestow his body in alms. He began by cutting off his hand: whereupon he was at once borne to Cailasa."

To this succeeds a series of miraculous stories, inculcating bountifulness to the poor: some devotees after reducing themselves to poverty attempt suicide: whereupon they are as usual carried to Cailasa. Several of these tales are interesting, but they are very long. One of these men is visited by Siva disguised as a Sudra who refuses to honour the god adored by his Jangam host: the zeal of the host is aroused and he attempts to slay his guest, who thereupon displays his real form and carries the zealot to Cailasa.

The narrative concludes with the moral that faith avails nothing if clogged with pride. Pride ruined all the pious acts of Nambi, who therefore long lingered on earth.

* Parallel to the Romish legend of the Virgin Mary, taking the place and doing the duty of a devout nun who eloped for a period from the convent.

The book closes with praise of Basava as being really the god Siva.

The fifth book commences with the life of a very celebrated saint, Kinnara Bramhaya (or, Bramhaya *of the harp*). He distributed all his goods among the Jangams and then lived as a harper. Hearing of Basava's liberality to all the worshippers of Siva he resorted to him. After dwelling with him for some time Bramhaya one day saw a (vitaca) gallant carrying a sheep to his mistress. The sheep escaped and ran into the temple of Siva. Bramhaya begged it might be spared, on the plea that it had thus offered itself for sacrifice : so he offered to pay for it : the price being half a (varaha) pagoda : but the man demanded 2,000 pagodas for it. This money he obtained and paid. The man then got two other sheep for the woman ; but she chose to demand the original sheep alone. He therefore attempted to wrest the sheep from Bramhaya who in the struggle cut off the man's head. His relations complained to king Bizzala, who sent for his minister (Basava) and reproached him with the deeds of his fellow zealots. Basava recommended an enquiry into the circumstances on the spot. The king therefore repaired to the place, and the god was called on to bear witness. Siva thereupon burst forth in divine form in flames and thunder, which ceased at their entreaty : the king then offered homage to Bramhaya who consented to restore the dead man to life.

The next four legends are full of miracles, but they are not so popular as to call for notice. We may remark that in these stories Basava is by no means exalted over his brother zealots. It is stated that (on visiting a very charitable woodman, named Moliga Maraia) Basava looked upon himself as sanctified by eating in the house of so excellent a person ; he even envied the birds and beasts that were at this holy abode. On Basava's offering homage to Maraia, he replies by attributing divine honours to Basava, saying all I do is by thy grace : Basava is much shocked at this homage, and replies, have mercy on me a poor inferior creature : as far beneath thee as a crow is beneath an eagle ; for I am the very abode of all sin.*

The next legend is regarding Cannada Bramhaya, a saint of a singular temperament, being (like saint Nicholas) by trade a housebreaker. If on breaking into a house he found that the inmates were worshippers of Siva, he spared them, but shewed no such delicacy towards those as were not of the true faith. He once was digging through the wall of king Bizzala's treasury, and on entering he met Basava, who being the trea-

* His crossing the river dryshod is another incident paralleled in the legend of Saint Kentigern.

surer, invited him to walk in and help himself. On hearing this the king was much displeased, he came to the treasury, found the hole made and the money lying about. On asking an explanation of the affair, Basava told him that this was the doing of Cananda Bramhaya (Bramhaya the *borer of the spade*), who is a great saint The king raised a query, how a house breaker could be a saint. Basava replied that he bestowed his plunder on people of the true faith* ; adding that he had broken into the treasury with the best designs towards his majesty. Then the thief carried home a party of the Jangams and gave them a dinner.

In the next legend a saint feasts his friends on poison nuts, which prove harmless. Another raises a corpse from the dead. In the next story narrating a journey made by two devotees, there is mention of a fig tree called the *Basava fig tree* : so called from two bulls (the word *basava* meaning a bull) having fought on this spot. On approaching the tree they see the deity (Basava) therein and worship him. They next cross a river dryshod, the stream giving way before the brandished sword of a devotee. The blessing given by a saint to a virgin wishes her a century of life : but she next day dies, and he restores her to her parents.

In the next story certain (ajnulu) unbelievers dress up a semblance of a corpse which they bear before the house of a saint to see if he could detect the delusion : but he went up to the bier and took the doll up by the hand and raised it to life. This of course persuaded his opponents of the truth of his creed.

Another saint named Suraya Candaia who worshipped Siva, used to pay yet greater homage to the Jangams : for he adored them first, and the image afterwards : thus reversing the usual rule. Another used to listen to his guests while eating, and declared that he heard Siva himself masticating. Nay he literally fed the *image* hanging at his neck, which actually ate with him. Another saint and his desciple are visited

* Precisely the doctrine taught in Parnell's tale of *The Hermit,* wherein the angel steals a gold cup which he bestows on a miser. It frequently occurs in Hindu writings. Thus in Vemana, III, 134. "To give away what is our own is easy : he alone can be called liberal who scruples not to bestow in gifts the property of others." Likewise in the Bhascara Satacam, verse 42, *Danamu seya cori,* &c. "If the liberal man when "desirous to bestow a gift, should lack the means, let him resort to the goods of "others : as the cloud waters the desart with streams which it borrows from ocean." The same principle may be seen in the laws of Manu ; and also in the Musulman rules regarding the right that the faithful have to the goods of idolaters. Indeed Parnell' ale has been traced to an Arabian source.

by a troop of fairies (gandharva) with their wives, who protest they took the saint for a bear, and his disciple for an ox. He therefore cursed them to be born as brutes. They were released from the curse by falling under the arrows of a worthy named Zommaia, who continued to offer seven animals daily to the image.

This story is evidently copied from that of Cannappa the savage, mentioned in the third book. It is the only Jangam legend wherein I have met with the mention of curses.*

This story concludes the fifth book: and the sixth describes those acts of the saints which were performed to confute the assertions of the Jainas. For instance; a Jaina defies a devotee named Ecanta Ramaya, and tells him that he is willing to adore Siva if the devotee will prove his faith by beheading himself. This the saint declined as inconvenient, replying that this step was superfluous; as numbers of the devout had cut their heads to Siva, and then recovered life. He proceeds to tell various legends.

In the first of these a saint cuts off his head, and recovers it at the end of three days. Another thinks this delay must have arisen from the want of faith: so he cut off his head before the god who instantly replaced it with another: and this feat was encored till the temple was full of heads. The next stories are regarding Jaina persecutions: one Jangam is condemned to the flames, but fire will not burn him. He then is released and destroys the Jaina images. Another is a blind man who as a good deed digs a well, which the Jainas fill up. He gains his sight and they go blind.

The next is a legend of Siva and Parvati descending from heaven to visit a Bramin boy, who thereupon embraces the Siva creed. This fable is very long but is narrated in a pleasing style of poetry. This Bramin is allowed by the king to hold a public disputation with the Jainas. The Jainas now by their spells invoked the god of fire to destroy him, but he remained unhurt: this is interpreted as meaning that they tried to kill him by burning his house. The Bramin now inflicts fever on the king, and the Jainas are unable to cure him. The Bramin not only cures

* A curse is the mainspring of all the braminical narrations. Throughout the Mahabharat this engine is constantly brought into play: even the present fable of Cannappa is of braminical origin: for the legend is traced to the Skanda puran. We may recollect that a curse is the first moving cause of the Iliad, the Odyssey and the Æneid; as well as in the *Bhagavat* and the *Cloud Messenger*. But the peaceable puritanical style of the Jangam books rarely admits even the mention of a curse, and this is perhaps the only instance of one of their saints resorting to that braminical weapon.

him, but removes a hump from his back. (This is one of the legends told in the Socca-Natha Lila, or, Madhura Puran).

The Jainas having declared they would acknowledge no proof save that by fire, the Bramin now wrote a Siva spell, and cast it into the flames with a Jaina spell : the Jaina incantation is burnt, and the other is preserved. The Jainas now propose the water ordeal : and the writings of both creeds are cast into the Cavary ; in this also their books perished, and the Saiva books floated.

The Siva disputant, who is named Pilla Nainar, now set up a number of iron spikes on which he impaled the Jainas. This persecution is countenanced by a king. Another account in the next page states that the Jainas were saved because they embraced the Saiva creed.

These stories regarding the Saivas and Jainas, appertain to an age previous to that of Basava.

The same narrator adds the following legend. There was a faithful devotee named Nami Nandi, who used to collect *ghee* (butter) as alms, wherewith he lighted lamps in the temple of Siva. The Jainas opposed him, and as he could get no oil he complained to Siva, using the common threat of suicide. The god thereupon appeared to him, and desired him to fill the lamps with water which burnt remarkably well. Then the god smote all the cattle that supplied the oil butter : and the people humbling themselves before Nami Nandi, the saint restored their cattle to life—and they embraced the Saiva creed.

Another saint named Sankhya Tonda, lived in the Chola country : he was the son of a Buddhist, and as he could no where find men who adored Siva, he prayed his god to destroy all the Jainas ; and, added he, until thou grantest this prayer, I will daily fling three stones at thee. At last Siva appeared, stretched out his arms, embraced him and granted his prayer by destroying all the Jainas in the town.

The next legend is of a saint named Covvuri Bramhaya, who held discussions with the Jains, and as they demanded a miracle, that of reviving a tree from its ashes, he accepted the challenge, and this convinced them.

There was a Jain guru, who was the confessor to a petty prince or baron named Desinga Ballahu. But his wife Suggalavva, had a Saiva named Devara Dasaya as her spiritual guide. She requested him to destroy all the Jainas. But the Jins* slandered him to the king, who counselled her that it was very wrong for a husband and wife to have

* Jina or Jina Deva, is the name used for the deity by the people who call themselves Jins, or Jainas.

separate confessors. She was offended and replied that a penitent is just as strongly bound to the confessor (guru) as a wife is to her husband. She reminded him that this was stipulated at the time of their marriage: and it would be better that they should separate than break that promise. Assemble your Jins, said she, and let them dispute with my confessor, and let the termination of the dispute decide our creed. This debate took place. Devara Dasaya asserted that the deity (Siva) pervaded all the universe. They replied, if your god fills all space, it surely is superfluous to assemble in temples to adore him. Dasaya replied:—" The king rules the whole country, but it does not hence follow that every one of his subjects is king. There is no occasion to attend temples as the deity is present with us all. Consider, the Chandra canta stone (selenites, amber) has the lunar influence inherent, and melts at the lunar ray; so does the heart of the pious man melt at the divine influence: for in him the deity is inherent. If we desire to have the milk of the cow we must buy the calf too: for it alone influences the udder to flow: thus none but the faithful adorer can derive any good from worship. The pearl shell rejects all common rain and is impregnated with pearls only by the genial showers of (Swati) the asterism Arcturus. In like manner the faithful Vira Saiva's heart expands to the influence of Siva alone."

They then asked whether Siva was the body or the soul of the world. He replied " Life and its properties do not appertain to the divine being. The living soul is in bondage to works but the deity acts from will alone. The deity is in our bodies, latent, as fire is in wood or oil in seeds: coexistent and hidden."

They replied saying, you say that Siva fills all space, and add that the divine influence is immortal: while the vital spark is mortal. This should be proved. Besides there must be one common principle of life extending from brutes up to deity. Explain this.

He replied, oil exists in linseed though it is imperceptible.* The deity shall be attained by the wise, no fool can attain to him for he pervades all nature. Of this I will convince you by destroying this Jaina town (a town named Potla Cheruva) and as a mark of my power, said he, tell me what is in this jar—verily the deity is therein. So saying he produed a jar containing a snake: and on opening it the snake was found metamorphosed into a crystal (lingam) image. This convinced

* I omit some further argumentation, which is tedious, and just as inconclusive as the above.

his opponents. He then pulled down all the Jaina temples and set up this image to be worshipped under the name Uttar Eswara.

The next legend is similar: describing the setting up of Saiva images in Jaina temples. The next is yet wilder. The Jainas delude a Saivite who is blind, into one of their temples and setting his face towards (Jin-eswara) their idol, assure him it is (a lingam) an image of Siva: he worships it: whereupon the Jaina image burst to pieces and in its stead there appeared the image of Siva.

The prince Bizzala (who employed Basava as his minister) now opposes the Jangam faith; being himself a Jain. On one occasion he sets up an image of the god Gopala [this is the name of a braminical god: but it is stated that this was done merely to annoy the Virasaivas]. He desired all people to worship this image. A zealot named Bāçayya refuses to obey. The king complains of this: but Basava interpose stating that if Bāsaya neglected his duties he merited punishment but he could not be expected to honour a new god.

The next legend (told in the braminical puranas likewise) is that of Bhringi, and deserves notice (though pitiably silly) merely because very popular. This Bhringi was a devout servant of Siva (Jupiter) on Kailasa (Olympus) and wished to honour Siva in the rite called *pradaxanam* (encircling him, circumambulation). But he declined paying any homage to Parvati (Juno) and as Siva was in the (Arddha nari) hermaphrodite form* (the right half of his body being male and the left female) Bhringi asummed the form of a (*bhringam*) wasp and bored a passage for himself between these figures: thus excluding Parvati from his homage. The goddess was offended at this and by a curse dried up the zealot's body, abstracting all his flesh and blood, and reducing him to *nobody*. To comfort him Siva presented him with a third leg, and in this reptile shape Bhringi (Tripos tripudians) appears in all the Siva temples, being an especial favourite with the god, and celebrated as a dancer, though a dwarf. Basava tells the king this story to shew the value and potency of faith.

A variety of other legends of miracles may be passed over; as deserving less notice than a dispute regarding the comparative potency of Siva and Krishna, who is the great god of the Bramins. The sermon against Krishna is delivered in the presence of the king by a Jangam named Bachi Devaiia.

Both Krishna, said he, and all the other gods are vastly inferior to Siva. For, were they really mighty how does it happen that they cannot

* See the prints in Moor's Hindu Pantheon.

vindicate themselves when misfortunes befal them? Neither Jainas nor Bauddhas worship the true god. Siva alone is supreme.

This book closes with a violent attack (in 400 lines of verse) on the adorers of Krishna (Vishnu) who is declared to be by their own confession not only a sinner but subject to degradation and death: "Vishnu was finally expelled from earth for his crimes and took refuge in the ocean." Siva is declared to be the supreme being, "one of whose servants would suffice to destroy Vishnu with all his adorers". At the close of this discourse, the prince (Bizzala) renounces the new braminical god (Gopala, or, Krishna) whom he had lately set up.

The seventh and last book (containing more than 2000 lines), describes the homage paid by Basava, as king's minister, to various *pariar** saints who adore Siva. The Bramins complain to the baron (Bizzala) of this conduct: and being summoned, Basava brings the pariar (sitting with him in his palankeen), to the palace. Being therefore excluded, Basava spreads his shawl at the gate and with his pariar friend seats himself on it. The king reproaches him for behaving in this manner, setting at defiance all the rules of caste: and expresses his apprehension that this may bring a curse on the land and heaven may withhold its rain.

Basava replies by telling some stories to prove that pariars are quite as good as Bramins, and that caste itself is a mere braminical device. He states that "the Vedas define but two castes, namely (*pravartica* and *nivartica*) the *active* and the *contemplative*. What avail *castes* recently instituted? Surely faith (bhacti) is the only point in which one man is superior to another. The Bramins here present are totally inferior to this pariar.

Then follow other extravagant stories wherein "the *dog* of a worshipper of Siva is declared as good as any worshipper of Vishnu"—Of a snake that dies as a punishment for biting a Jangam—Of a Jangam girl who considered herself defiled because touched by a Bramin woman: "because touching a Bramin would be a defilement even to the dogs of a Saivite's house. The Bramins are annoyed at being set below dogs,

* The word *Pariar* is originally Tamil, *parey*, plural *pareyer;* and signifies *a drummer* (from *parra*, a drum whence parrayan). For the pariahs hold the hereditary village employment of *Toty*, or *Vettiyaun:* answering to the Saxon villein, or serf and one of their stated duties is *to beat the drum* on public occasions. The Spaniards have used this Hindu phrase in South America: where they apply it to labourers and Indians: from Brazil too, they brought the word *peon* which there signifies either a foot soldier, household servant, or a labourer in general.

and affirm that at least a dog cannot read the vedas: a Jangam, however, desires his dog to try, and it succeeds very well.

Besides, Basava assures the baron that in many houses the dogs read the vedas quite as well as their masters. This is not impossible.

A zealot hears a man reading the legends in honour of Vishnu: but avoiding those which speak of Siva. Unable by argument to persuade the reader to do justice to his patron god, he killed him.

A woman who is a leper is driven out of the town by the Bramins: she attempts to visit a Siva temple: the god meets and heals her, and inflicts the leprosy on the Bramins. There follow many more miracles.

Basava's zealous exertions had now encouraged the Saivites to treat the Bramins and their temples with great neglect: and the king receives many complaints that the Jangams were gradually infringing on the rights of all other creeds. Some complaints are made by (boyas) herdsmen: who now lost the dinners (prasadam) which they (as cowherds) had hitherto been used to receive from those who formerly worshipped at the temple of Siva.

On being questioned regarding this by the prince, Basava declares that these men had a claim to the (prasad) blessed food bestowed at the Siva temples, but had no right to enter the houses of Jangams nor even to see their food. The claimants replied that at Casi, Gaya, and Prayaga (the sacred cities), they enjoyed this privilege: and therefore claimed it. He answered that they could claim nothing that is not *offered* at a Siva *temple*. " We of the Vira Saiva sect, he added, will not even tolerate the sight of a Saivite. But, said he, if you choose, you may dine with me to-day on poison; I shall be happy to see you."—The story ends in Basava eating the poison with impunity, through the power of (prasadam) the benediction which he utters over the food.

Bizzala then looks upon Basava as more mighty than Siva himself, as having swallowed the poison: whereas Siva does not venture to swallow the venom, and merely holds it in his throat. This alludes to a well known story regarding Siva.

On another occasion Basava is invited to dine in company with some Bramins and declines it: because he will not eat with those who neglect to bless the food in the name of Siva.

The next is a story about some cows which are faithful to Siva, and refuse food offered to them by any but Jangams: indeed, they will not eat until they behold the image and make an obeisance to it. " Thus a cow in the house of a devotee has more religion than a Saivite: then how can you be so brutish as to wash the feet of Bramins?"

Another devotee's wife bears him twins: he has provided only one image, which as usual, he hangs at the neck of the first born, and for want of a second he refuses to receive the second infant. This is applauded as a mark of great devotion.

Basava further says to the baron, "How can I convince you of the supremacy of Siva? it is as idle as teaching a blind man what light is. Your conduct is as foolish as using a golden plough, and then sowing thistles. Consider how unavailing were the sacrifices offered to Bramins by Gautama, by Dadhíchi, by Daxa, the emperor Bali and others No honours that you can offer to Bramins can in merit equal worship offered to the (lingam) image."

His friend *Jagad-Eca malla* is convinced of the folly of adoring Bramins, and offered his thanks to Basava: who now spoke to him in confidence, saying after a short time a dreadful crime will take place here: and you are to slay him who commits it: after which Siva will appear visibly to you.

There were two brothers named Allaiia and Madhupaiia constantly in attendance upon Basava: the baron (Bizzala) caused their eyes to be put out. but Basava and the other worthies restored their sight, after which they blotted out all the accounts kept in the royal treasury. They now sent for Jagadeca Malla, and told him that the appointed time was come for him to slay an offender. Basava now retired from the town, which was immediately filled with outrages, so much so that the devotees fled from it. Malla was appointed to put the baron Bizzala to death but went home without effecting this. His mother reproached him for failing to obey the command of Basava. She said, surely had they wished it the worthies were well able to do this themselves: they entrusted it to you merely as a favour conferred on you. If you disobey them I wish you may become a dog and live on (prasadam) rice given as alms.

Hereupon she treated him as a dog, and threw rice on the floor for him to eat. But the other worthies came to console him, and even ate what he left. They then led him to the palace of Bizzala whom these three men slew.* They then returned home, and Malla paid homage to his mother. Then remorse at the crime made them seek to kill themselves, but their god Siva appeared visibly and carried them all to Cailasa.

* This murder resembles the deed committed in the House of Commons on 30th Dec. 1654 (see Salmon's Chronological History), when a quaker wounded several people declaring that he was inspired to slay every man who sat in that house.

After the death of Bizzala,* Basava retired to the pagoda at Cudali Sangaweswaram, and prayed to Siva to take him to himself. Hereupon the god came out of the temple and appeared in visible form, and on being adored by Basava took him to himself (*aikyam*, unitedness, oneness, took place), while the people sung his praise: and thenceforward all the worthies adored Basava as being Siva himself.

The poet concludes by apologizing for the prosaic style in which he has recorded *the History of Basava.*

In a former essay, on the Jangams, it has been shewn that from local records the death of Bizzala appears to have occurred in the saca year 1090 or, A. D. 1168. Dr. Francis Buchanan, however, gives a more remote date (357 years earlier) to the events in question. He states that " in the year Vicrama (3875 of the Kaliyugam), Basava went with his sister to Kalyanam"—and specifies that this corresponds with A. D. 775; and " the time for Basava's remaining on earth terminated in the year Raxasa, 3911 of the Kaliyugam"—adding that this corresponds with A. D. 811: and that Basava's " absorption" or death took place on Wednesday the first of Margarisiras, at 21 hours (ghurries) of the night. Vide Buchanan's Journal in Mysore and Canara, 4to, vol. 3, p. 264.

But this author does not cite proofs of the dates thus minutely specified: and the later calculation (placing the death of Bizzala in A. D. 1168) is more likely to be correct.

Somia of Pidupādu (in his preface to his Padya version of the Puran) states that his ancestor, Somanatha of Palacurru, wrote the dwipada puran in the days of a prince named *Pratapa Rudra.* (This king according to Colonel Mackenzie reigned at Warangole from A. D. 1456 to 1477). And he adds that in those days the fear of the approaching Mahomedan rulers was prevalent. This agrees with the known period of the Mahomedan invasion of Warangole.† That puran is written by Somanatha in Telugu: it mentions no earlier poem: and is considered by the Jangams as their most ancient record.

The strong antipathy that exists between the Bramins and the Jan-

* It will be remembered that the *Jaina* account of this murder deviates in several important particulars: and probably is the true account. It is printed by Mr. Elliot in this Journal for 1838, page 212. The miraculous absorption of Basava's body is evidently meant to denote that he was not buried.

† See Briggs's Mahomedan Power in India, vol. 2, page 311, date of A. D. 1368 and page 448 of A. D. 1456.

gams makes each party avoid mentioning the authors respected by their opponents. This renders a comparison of dates far from easy. The Jaina chronologists mentioned in the former essay have perhaps recorded the true dates of the history: and the precise antiquity of the *puran* is interesting to those who cultivate Telugu literature; because the peculiarities of the dialect give reason to believe it the most ancient existing composition in the language.

POSTSCRIPT.

Those who wish well to the literature of India will hail with pleasure a notification which appears *in the Foreign Quarterly Review*, regarding a society now founded in London "for the advancement of Oriental Literature *by the publication of the Original Texts*." With the Earl of Munster as President, and Professor Wilson as Vice President, there is every prospect of its leading to results highly desirable. The *Devanagari* texts may be best published in Bengal or in Europe: that type being foreign to Southern India. But the Telugu, Canarese and Tamil printing (including Sanscrit publications in those alphabets) to be rapidly, cheaply, and correctly executed, should be ordered to be done at Madras and other towns, where we find an abundance of presses well supplied with the requisite types; and where there is no want of skilful compositors who are themselves natives.

As noticed in a former page of this Journal* it is much to be regretted that an ample collection of native literature, more than a thousand volumes, in the Telugu, Tamil and Canarese characters, should be removed from their proper sphere and lie useless in London; part being at the India House and part at the Royal Asiatic Society's Library; while at Madras we often are at a loss for the aid they might afford. In those museums I found some volumes (treated as mere curiosities) which if transferred to Madras might do solid service to Indian history and literature. Regarding remote times, the documents are not wanting: books of a date earlier than the Mahomedan invasion are easily found. But the bigotry of the Mahomedans and the indifference of the English rendered the survival of the more modern native literature precarious, and several works of merit may now depend (as did the writings of Phædrus) on a single manuscript. Because during these ages of neglect a volume however excellent, was but seldom transcrib-

* Madras Journal, No. 26, page 177.

ed; and some works have become as scarce as are the MSS. of Aristophanes. Some of these have found their way to England: and as a case in point there is a work (the Parama yoga Vilasam, in Telugu) of which I with much difficulty obtained one copy at Masulipatam: two others (incomplete) have with his usual kindness been transmitted to me by Professor Wilson: and another manuscript I discovered at Oxford in the Bodleian library, whence I yet hope to obtain permission to borrow it. I would willingly transmit a more legible copy along with it in returning the original, which if left to its fate will perhaps before long feast the worms.

VI.—*On the Structure of the Sevâlik Hills and the Organic Remains found in them.—By* Proby T. Cautley, Esq., *Capt. Bengal Artillery, F. G. S.**

The mountains, a part of which I am about to describe, range (with the exception of the debouchures of rivers) almost uninterruptedly from the Sutluj, which separates the territory of the British Government from that of the Sikh chieftain, Runjeet Sing, to the Burhampootur river, and the district of Cooch Behar. Their general bearing, in the portion near the Sutluj, is N. W. and S E; but in that approaching the Burhampootur, it is many points nearer direct east and west. They lie at the foot of the great Himalayan chain, with which they are in some parts connected by a succession of low mountains; but in others, as in the districts under review, they are separated by valleys from three to ten miles in width, and called by the natives Deyra Dhoon, Kearda Dhoon, &c., or the Valley of Deyra, the Valley of Kearda, &c. The highest peaks do not far exceed 3000 feet, and the generality of the summits vary from 2000 to 2500 above the level of the sea. It is necessary, however, to premise, that my observations have not extended further eastward than the Ganges; and that whatever I may record, in this paper, beyond that river, is given on the authority of others.

Between the Ganges and Jumna rivers, this line of mountains is separated from the great chain of the Himalayas by the Dhoon, or valley of Deyra, the average width of which may be under ten miles. At the

* From the *Transactions of the Geological Society of London*, Second Series, vol. 5.

Ganges, or south-eastern extremity, a road passes between the chain and the river; and no difficulty whatever is offered to the approach to the valley. At the opposite or Jumna extremity, on the contrary, the mountains are in many places scarped into the river; and the footpath used by the boat and raft people, is an irregular track, over ridge and through hollow, and impinges upon the river at those points only where the stream, in its meandering course, strikes the opposite side of the channel. The intermediate roads, or ghàts, follow the rivers or hill-streams; for in such an utter confusion of mountains, any other passage is impossible. A few of these roads are passable for wheeled carriages, but the generality are bad footpaths. Between the Jumna and the Sutluj are two other valleys, the Kearda and the Pinjore, separated from each other by one of those complex masses of mountains which connect the lower with the upper Himalaya range. The hills are generally less precipitous in this neighbourhood; and the higher points and ridges are separated by valleys, affording a drainage to the country, and displaying on each side high and beautiful sections of the stratification These valleys, or plateaux—for, with reference to the rivers running below them, they may be considered as such—vary in width, but extend along the whole course of the mountain-streams.

As much confusion may be avoided, in the absence of a native name for the whole range of these mountains between the Sutluj and the Burhampootur, by establishing one, which may be considered legitimate, I wish to propose that of Sevâlik,* formerly applied to the portion be-

* In Smith's Exotic Botany, vol. i. p. 9., is the description of the *Rhododendron arboreum:* he refers it "to the mountainous tract called the Sewalic chain, which separates the plains of Hindostan, between 75° and 85° E. long. from the Himalaya mountains. I make the quotation for the value of the name, though the statement is evidently wrong; the rhododendron in question growing in the Himalayas themselves at a high elevation, and in company with oaks. The chain separating the plains of Hindostan from the Himalayas, which is the one now under review, is subject to a mean temperature perfectly inimical to oaks and the *Rhododendron arboreum.* The name is quoted also in Dow's History, and in some traditional writings in the possession of the high priest or Mahant residing at Deyra. The derivation supplied by the high priest is as follows:—

"Sewalik, a corruption of *Shibwalla,* a name given to the tract of mountains between the Jumna and the Ganges, from having been the residence of Ayshoor Shib, a name of Mahadeo and his son Gun, who, under the form of an elephant, had charge of the westerly portion, from the village of Doodhli to the Jumna; which portion is also called Gungujur (*gujur,* elephant): the portion eastward from Doodhli, or between that village and Hurdwar, is called Deodhar, from its being the especial residence of Deota, or Ayshoor Shib. The whole tract, however, between the Jumna and the Ganges, is called Shibwalla, or the habitation of Shib."

tween the Ganges and the Jumna; a name which appears to me better than that of the "Lower Hills" or the "Sub-Himalayan," terms, equally applicable to the subordinate ranges northwards of the Himalayas.

These preliminary observations will make the reader acquainted with the field of our fossil discoveries; and I proceed to the description of the geological features of the tract. The formations composing the hills, consist of beds of boulders or shingle, either loosely mixed or agglutinated by clay and carbonate of lime; of sands of various degrees of consistency; of marl or clay conglomerate;* and of an infinite variety of clays; the two latter being most extensively developed to the westward of the Jumna. The strata dip from 15 to 35 degrees, generally towards the north; and the breadth of the inclined beds is from six to eight miles.

The succession of the strata is irregular, with the exception of the shingle in the more northern tracts, where it appears to overlay as well as to alternate with the sandstones; whereas, although the debris is in considerable abundance in the water-courses, and on the flanks of the hills, I have never met with these shingle-beds south of the most northern half of the hills. A similar remark applies to the marl, but in a contrary direction, as it occurs only to the south. The want of the marl in the northern sections may be accounted for, by suppossing it to have been either a local deposition or a general one, which is not exposed throughout its entire range.

Although I consider the whole of this tract of mountain as composed of one formation, it may be of use to divide the portion between the Jumna and Ganges, from that westward of the former river, as it appears to me, that there is a marked difference (as before stated) in the shingle strata, as well as in the position and number of the clay beds; although perhaps nothing further than would be exhibited on any extended line of country, formed of debris from different tracts of mountains. The causes which upheaved this district, apparently acted more energetically in the contracted surface eastward of the Jumna, than in that to the westward; though, in the latter, the surface upheaved is much more extended. I shall therefore divide these notes into two

* I call this stratum clay-conglomerate, the beds being composed of fragments of an indurated clay, cemented together by clay, sand, and carbonate of lime; the clay itself effervescing strongly with acids. The rock is, in general, exceedingly hard and tough, as is shown in those parts where it is in contact with the stream of the rivers, which appear to have had little power upon it.

sections; the first consisting of the tract between the Jumna and Ganges; the second, that westward of the Jumna. To commence, therefore, with the range between the two rivers.

Hills between the Jumna and Ganges.

Shingle and Sandstone.—The beds of shingle are of enormous thickness, and alternate with the sandstone. The former precisely resemble the shingle in the beds of the existing great rivers of the country, and consist of boulders of granite, gneiss, mica slate, quartz, hornblende schist. and traps; and every other rock, through which these rivers hold their course. If the beds of the Jumna and Ganges were to be upheaved, in the same way as those of former rivers, the appearance of the strata would be exactly similar. The sandstone consists either of grains of pure quartz, with different proportions of mica, or of an admixture of the other ingredients so common in all river sands. The presence of oxyd of iron causes a great variety in colour, from red to gray, whilst the induration of the rock appears to depend on the proportion of carbonate of lime. In the more easterly limit opposite Hurdwar, as well as other places, the stone is quarried for building; and in many localities where it is crystalline, it is highly valuable in architecture. On the Jumna are the remains of an ancient hunting palace, built by the emperor Shah Juhan at the end of the 17th century; and although now in utter ruin, amongst its fragments are capitals of columns, and scolloped arch work, &c. cut in this sandstone, which prove it to be well adapted for architectural purposes. It is easily worked, and the mixture of mica gives two splitting surfaces. On exposure to weather, however, it exfoliates and crumbles, as is conspicuously shown in some lintels, still in position at Badshahmuhul. The colours of the clays are endless; and a light blue variety, which is found under the marl, as well as higher up in the series, where it contains fresh-water shells, is exceedingly pure. The strata of this blue clay are thin, but those of the other varieties are of all dimensions.

Lignite.—Carbonaceous matter occurs throughout the sandstones, either in detached fragments exhibiting vegetable origin, or in strata or seams composed of sandstone and lignite in equal proportions. Lignite is also found in the marl, but generally in the form of black dust; leaving, on its removal, an indistinct, vegetable impression. In one instance, I also met with it in the shingle strata. It has never been found in sufficient abundance to excite an inquiry as to its adaptation for œconomical purposes; though it is common to the whole of this tract of mountains.

Eastward of the Ganges it has been found, to the north of the Moradabad district; and it agrees in every respect with that found elsewhere. It has also been met with at points still more easterly; but the examination of that tract has been very slight. The most interesting point at which I have found lignite, is at the mouth of the Kalowala Pass, one of the entrances into the Deyra Dhoon, from the plains. A stratum or bed of yellow and red sand, about 18 inches thick, is there completely charged with lignite, either in long flattened masses, or in transverse sections of trunks of trees, which show, by their elliptical form, effects of vertical pressure. The lignite, in these cases, constitutes merely the outer covering; the interior of the trunk being composed of the sandstone matrix. The bed is enveloped in strata of the marl, abounding in the remains of animals; and both the lignite bed and the marl, appear at this point most distinctly to have been deposited in a hollow; the beds, at their lateral extremities gradually attenuating, until they meet the sandstone rock; and the lower surface being concave. Although the marl is evidently limited at this spot, it seems to exist so generally in extended strata, that, supposing it to have formed tracts of marsh land, those tracts must have been very extensive. I have before remarked, that I have seen the marl only on the southern limits of these hills, between the Jumna and Ganges. In crossing the former river, however, the same stratum, with the same organic remains, is met with on the north of the mountain ridge, on which the town of Nahun stands. Here the upheavement has been more violent than elsewhere; and the point of junction of this tract with the higher Himalayas is consequently much dislocated. It is necessary to state, that there are appearances of trap* in the neighbourhood of these disturbances; a fact which may lead hereafter to an interesting geological disquisition on the point of junction. Fossil wood, apparently *dicotyledonous*, abounds in the sandstone The woody fibre is generally perfect, but impregnated with the sandstone, and frequently mixed with carbonaceous matter; in which case the fossil is black, and on fracture has the appearance of an intimate mixture of coal and sand, or of an imperfect coal. The only remains of animals yet found are fragments of tortoises.

Marl, with Organic Remains.—As the marl is in greatest abundance in this section, I will now give an account of its organic remains; confining myself to classes and genera. These fossils are in appearance perfect, and the deep black colour which they have derived from hy-

* Dr. Falconer has made the same observation. Journ. Asiatic Soc. Bengal, vol. iv. p. 50; date of communication, 3d January 1835.

drate of iron, renders them ornamental. The medullary cavities are, in many cases, filled with pyrites, and in others with pure white crystallized carbonate of lime. The greater part of the fossils, already procured, is from the deposit in the Kalowala Pass; and as my collection is not only large, but abundant in different genera, the number already found in such a limited space, indicates the great variety of animal remains, which a diligent and extensive search may produce. Teeth, and the more solid part of the bones, are found in the greatest quantity. Most of the former are perfect, and as sharp in their outline as when the animals existed; and even in the fragments, the sharpness of the fracture proves, that they were quietly deposited in the sediment in which they are found. The following is a list of the fossils already discovered in the marl:—

MAMMALIA.

Pachydermata..... Teeth, and the remains of a species of *Anthracotherium.*

Carnivora...........Genera doubtful; but some of the teeth correspond with the third incisor of the bear.

Rodentia.......... ...Rat, and a small variety of castor.

Ruminantia ....Deer, several varieties, and one molar of a very small species.

Solipeda..........Horse, one incisor, and one molar from the right side of the upper jaw: they exhibit a peculiarity in the form of the enamel flexures.

REPTILIA.

Crocodilia...........*Ghariál.* (*Gavial* of naturalists.) Teeth and bones in abundance.

Crocodile. Teeth, in great abundance, fragments of the osseous plates, vertebræ, and other bones.

Chelonia.......... .*Emys.* Fragments of the plates of the back very perfect; also ribs, with the attached osseous part of the buckler.

Tryonix. Ditto, ditto. Some marked differences in the form and position of the rugous surface of the fragments of the buckler, may hereafter point out a variety of species.

PISCES.

Vertebræ and Scales—The latter doubtful.

TESTACEA.

Bivalve..............Imperfect, but resembling *Unio. Univalve :* a cast resembling that of the *Paludina* of the present fresh-water.*

Besides these more easily determinable remains, there have been found a number of incisor teeth, which I cannot assign to any genus; also quantities of bones, in fragments, and portions of ribs, one of which must have belonged to a large animal; also vertebræ, matatarsal or carpal bones, &c. With the exception of the teeth, the remains are generally in fragments, and separated; nor does it appear probable that we shall meet with anything approaching to a complete skeleton.

In the tract then between the Jumna and Ganges, the fossil remains as yet discovered are thus disposed :—

Shingle, or Gravel Beds—Lignite, scarce.

Sandstone ....Trunks of dicotyledonous trees in great abundance; lignite, and remains of reptiles.

Marl.....................Remains of mammafers, reptiles, fishes, shells, and lignite.

The mineral products are, carbonate of lime, the general cement of the whole formation, also in stalactites and stalagmites; selenite, in small tabular crystals; and pyrites, but apparently in the neighbourhood of organic remains only. Soda abounds throughout the mountains, efflorescing on the shingle and sandstone rocks; and the presence of this alkali may explain the partial disintegration of the boulders of which the shingle is composed: for, I believe, I am right in asserting, that every variety of boulder, from granite to quartz and sandstones, has been acted on: and when it happens that the boulders can be removed entire from the bed, they fall to pieces, either after exposure to the air for a time, or by pressure of the hand immediately. With regard to fractures in some of the boulders, and their consolidation on different planes, as in a slip of stratification, no remark whatever appears requisite, as these are the necessary consequences of that movement, which raised the beds from their horizontal position. There does not appear to be any further remark necessary on this tract, more than can be reserved for the general summary; I shall therefore proceed to describe the hills westward of the Jumna.

* The only univalve which has been yet found in the marl is the cast above-mentioned, from the rock north of Nahun. I have entered it here, considering, as I do, that the deposits are identical.

Hills West of the Jumna.

These, as I before stated, consist of the same series of shingle, sand, clays, and marls; but they differ, in the beds of shingle being less abundant, although equally inclined, and in containing a different description of boulder. The rolled fragments eastward of the Jumna are all of primary or lower rocks, whilst those to the westward are confined to varieties of clay slate, and quartz. The marl, which, between the Jumna and Ganges shows itself in the southern limits, is here exposed at a point north of Nahun, cropping out on the northern slope of the mountain ; and the fossil remains resemble those found in the marl eastward of the Jumna, consisting of mammafers, crocodiles, tortoises, fishes, and shells. From Nahun to the plains there is a succession of sandstones and clays, without any abundance of shingle. The sandstone, which, in the vicinity of Nahun, is much indurated, and used for building, becomes softer on approaching the plains; long before reaching which, the whole formation consists of an interminable succession of sandstones and clays, the latter being in the greatest abundance, of every variety of colour, and dipping, on an average, 20° to the north. The topographical outline of these mountains, shows a considerable southing of upheavement, in the hills westward of the Jumna: and the circumstance of the fossil remains abounding in the sandstones and clays in this tract, and not in that between the Jumna and the Ganges, may probably be due to the non-upheavement of the line on its prolongation eastward of the Jumna. The action, in all probability, was exerted irregularly; and although in the large scale we may lay down the dip and direction with accuracy, the former as varying from 15° to 35°, and the latter from N. E. to S. W., local details give very different results.

The sandstone rock, from which the fossil remains sent to the Society's Museum were extracted, reposes at the above angle, over numberless beds of clays, more or less rich in testaceous remains. The fossil bones lie in great abundance on the surface of the slopes in the neighbourhood of the sandstone, amongst the ruins of fallen cliffs, in the beds of water-courses, &c. The bones which we have had the good fortune to dig out of the rock are perfectly sharp, and in all their original perfection. I may here advert to a circumstance to which the preservation of the water-worn specimens is chiefly due. The sandstone is generally soft, but in the proximity of the fossils it becomes ferruginous, concretionary, and so hard as to turn the edge of the chisel; and thus protects the fossil from destruction in its progress, as a boulder along the torrent's bed. These concretions are occasionally globular,

and become singularly conspicuous, by the weathering of some of the ridges, when the mass of rock takes the appearance of huge spherical concretions piled confusedly on each other.

The organic remains of this sandstone yet brought to light, belong to the following classes and genera: most of the species are new; and the appearance of totally undescribed forms will add very considerably to our fossil genera. The new genera themselves will be the subject of separate accounts in their proper place.

Mammalia.

Pachydermata...Mastodon—elephant—rhinoceros—hippopotamus—hog.
Carnivora ... ...Canine and feline.
Ruminantia... ...Elk—ox—deer in great varieties.
Solipeda... ... ...Horse.

Reptilia.

Crocodilia........Ghariàl—crocodile; both very closely corresponding with the existing species now in the rivers. Lacertine remains indeterminable.

Chelonia.......Emys and tryonix; some of the fragments are of the most gigantic proportions. Of the smaller varieties, nearly entire specimens have been found; upper buckler and carapax complete. My cabinet also contains three heads, wanting only the occipital portion of the cranium.

Pisces.

Genera not established.

Many other fragments have been found, but so imperfect as to render a classification impossible. I may remark, that there appears to be no end to the variety as well as quantity of these remains; and we may expect to do much, even in this remote region, in advancing the inquiries respecting fossil zoology.

Of each genus above mentioned, with the exception of the horse and the carnivora, I have already almost perfect skulls. The bones of the body, however, appear to have been much broken and mutilated; but it is a singular fact, that from many places where the fossils have been found as mere debris of fallen cliffs, fragments of bone have been obtained, which have admitted of being joined, although the fractured ends were coated with carbonate of lime, as if they had been fossilized separately. A beautiful example of this, is exhibited in an almost perfect

rib of an elephant or mastodon, which is forwarded to the Society's Museum, and which consisted of no less than eight pieces. A perfect humerus of a ruminant has been secured in this state ; and the bones of two hind legs, namely, the upper part of the metatarsal connected to the lower portion of the tibia by the intermediate tarsal bones, with, also, the os calcis entire, and all the smaller bones of the tarsus equally so. These remains have belonged to an enormous animal, and, I believe, to the same genus as that of a skull in my possession, and now under description by my friend Dr. Hugh Falconer, of the Bengal medical service, and myself. Although I refrain from zoological details, I must mention, that we have an animal evidently forming a connecting link between the *Pachydermata* and *Ruminantia*, or between the *Tapir* or *Palæotherium*, and the latter order of mammalia. The hippopotamus of this sandstone appears to be a new species, having six incisive teeth, besides other peculiarities, particularly in the proportion of the bones of the head : the tusks also differ from those described by Cuvier in his Ossemens Fossiles. The great depth at which the marl lies beneath the upper strata, with the discovery in it of remains of the horse, is an interesting fact. In the sandstone strata the remains of the horse are by no means scarce. There appears, however, to be a local disposition in the deposits of these remains. In some places the hippopotamus, elephant, mastodon, crocodile, tortoise, &c., are found in abundance, with the remains of ruminants ; in others the hippopotamus and the water reptiles are almost totally absent, and only the remains of ruminants and carnivora occur ; all tending to prove that these animals were destroyed on the site of their habitats ; and that this former world was not more mysterious than the present ; that there were vast tracts of marsh and river, with their attendant hippopotami and crocodiles in the waters, and elephants and mastodons in the neighbourhood ; and that there were other tracts free from water and marsh, and frequented by their natural inhabitants, ruminants, carnivora, &c.

Dr. Falconer, in a note read at a meeting of the Asiatic Society of Calcutta*, suggested the identity of this deposit with that near Prome, some of the fossils from which have been so beautifully lithographed in the Society's Transactions†. The mastodons in the Sevâlik strata are in great abundance ; and as we have perfect skulls, we are enabled to form some opinion of the dentition and the change of teeth. Three of these skulls, now in my cabinet, have the front tooth worn, and the rear

* Journal Asiatic Society, vol. iv. p. 58 ; date of communication, 3d January 1835.

† Geological Transactions, 2nd Series, vol. iii. p.377 *et. seq.* ; pl. 36 to 43.

one coming into use; the whole line of teeth stretching on a surface of 19 inches, and forming an arc of 90°. The *front* tooth I cannot distinguish from that of the *M. Latidens* figured in the Geological Transactions; and the *rear* one, in the same animal, bears such perfect resemblance to the *M. Elephantoïdes,* that I cannot help risking the conjecture that the *M. Latidens* and the *M. Elephantoïdes* are one and the same animal; the specimens, from which the specific characters were taken, having been detached teeth.

Bringing this forward in the way of suggestion may be of use, in ultimately leading to truth. The question, however, must be determined by a strict examination of specimens; and having advanced the above supposition, I will take care that the means shall be provided.*

The minerals in this tract, west of the Jumna, correspond with those to the eastward, with the exception of the presence of the gold, which occurs in the beds of the rivers in these mountains, both eastward of the Ganges, and westward of the Jumna; but I am not aware of its existence in the intermediate tract. Under Nahun, gold-washers are constantly employed during the dry months; their daily return varying from two annas to two rupees, or from 3*d.* to 4*s.* The process is extremely rude. A piece of board, a long wooden trough, a ladle made out of a gourd, a sieve of the large grass which grows so abundantly in this part of the country, and a piece of hollow bamboo with a little quicksilver, constitute the portable apparatus of these most primitive washers for the precious metal.† A great deal of the gold-dust must necessarily be lost by this method of proceeding; and all the mercury, as it is evaporated in open air. The grains of gold are not larger than the small scales of mica, so common in river sand; and I have not heard that the metal has been found in large masses. This gold, too, has its localities, some streams being much richer than others. Where is the fountain head?

* The rear or newly-formed teeth of every species of mastodon resemble those of the elephant, so far as relates to the integrity of the apices or summits of their transverse ridges; and they might therefore be mistaken for those of the *M. Elephantoïdes*; but the observations which led to the conclusion, that the Ava specimens of mastodon belonged to two distinct species, were not made on detached teeth. A repeated examination of the jaws and teeth described by Mr. Clift, and the knowledge that his opinion was formed from considering the size and number of the transverse ridges in relation to the length and breadth of the teeth, have tended to confirm my belief in the establishment of two species, which I must retain until further and more definite evidence to the contrary is adduced.—Referee.

† See further particulars of the gold-washings in the Gûmté river, by Capt. Cautley, Journal Asiatic Society of Bengal, vol. iv. p. 279; Plate VII.; April, 1835.

In some stratum of this alluvium, perhaps, yet to be discovered, as the streams have no connexion with the higher mountains. A description of the washers , and the method practised by them eastward of the Ganges, have been given in the Journal of the Asiatic Society ; and as there is little difference in the apparatus used at both places, it is not necessary to refer to it further.

Some of the fossils obtained by Mr. Colebrooke in the hills near Cooch Behar, and described by Mr. Pentland*, are identical with some of those obtained by the present discovery ; and as the former were found in the most eastern extremity of this line, it is possible that a careful examination would prove the existence of animal remains throughout the whole of the intermediate mountains ; all the tract being probably tertiary. An inquiry into the difference between the hills bounded by the Ganges and Jumna, and those westward of the latter ; and into the confused and interminable dislocations, without any flats in the former, and the more scattered ridges with the intermediate plateaux of the latter, would only lead to a disquisition on the general formation of the dhoons or valleys lying between the Sevâlik hills and the great chain, which the limits of this communication will not admit, and must be left for future inquiry. It will be sufficient to state, that the general form of the mountains approaches more or less to a right angle, the long slope being covered with vegetation, and the crest terminating in a perpendicular and generally mural cliff, which descends into the beds of the torrents. The scenery from these cliffs is most picturesque, and many of the passes or ghàts up the torrents are bounded by gigantic walls of sandstone, varying both in height and character, and subject to all the tortuosities dependent on a river's course, forcing its channel through a complication of mountains. This effect is considerably heightened by the pointed and jagged style of the outline, depending on that abundance of clay and carbonate of lime throughout the whole formation, which permits even the shingle-beds to hold up their pointed summits in the wildest manner imaginable. At places, a perfectly inaccessible needle of shingle raises its head far above the others, and is crowned by one solitary fir tree, *Pinus longifolia*. This conical form, produced in the clays by weathering, is sometimes magnificently displayed, by the whole face of a cliff, consisting of light pink, yellow, and blue clays, being externally decorated with small conical spires of the clay from top to bottom, a height of 1000 feet from the bed of the river. The origin of this structure is due simply to a little coping stone, of some harder material than the

* Geological Transactions, Second Series, vol. iii. p. 393 ; Plate XLV.

matrix of the strata, and upon which the weather does not act so rapidly as upon the clay. Under a bright sun, the beauty of these cliffs, with their illumined pinnacles, is exquisite; particularly westward of the Jumna. I have before adverted to the presence of great abundance of lime, forming stalactites, and the cement of the sandstone and conglomerate. There is another striking method of deposition on the surface of the large stones which lie in the beds of the rivers, and which, during the greater part of the year, are in contact with the water. The substance is very similar in appearance to the coarse brown paper made in this country; and is produced by the water, while washing the stone, depositing its lime, and entangling the finer particles of vegetable matter, sand and mica, until the stone acquires a superficial coating, of a brownish yellow colour, which on removal resembles the substance before mentioned.

Note by the Editor Geol. Trans.

For detailed descriptions, by Capt. Cautley, Dr. Falconer, Lieut. Baker, and others, of the most important animals found in the Sevâlic Hills, see Asiatic Researches; Calcutta, 1836; vol. xix. Part. I.; and Journal of the Asiatic Society of Bengal, No 35. vol. iii. p. 527; Nos. 45, 46, and 48. vol. iv. pp. 495, 565, 706.; Nos. 49, 53, 55, 57, 58, 59, 60. vol. v. pp. 38, 291, 294, 486, 579, 661, 739, 768.

VII.—*Notice on the Remains of a Fossil Monkey from the Tertiary Strata of the Sewalik Hills in the North of Hindoostan.**—*By Capt.* P. T. Cautley, *F. G. S., Bengal Artillery; and* H. Falconer, Esq., *M. D., Bengal Medical Service.*

The most highly organized mammifers hitherto described in a fossil state, so far as our information extends, belonged to the *Cheiroptera;* and the instances of these on record are very few.† That quadrumanous remains should be wanting is by no means surprising, without the necessity of supposing that they did not exist. The countries of which the ancient races have been most completely investigated, had a climate unsuited to be the habitat of the tribe, as we now know it, when the

* From the *Transactions of the Geological Society of London*, Second Series, vol. 5.

† Brewster's Edinburgh Journal of Science.

more recent or superficial deposits were in progress of formation. If we refer to the remote epochs when the climate was suitable, and when genera now associated with the Monkeys were abundant, it is easy to conceive that the latter might have existed in numbers, without their remains being entombed. It requires in all instances many unconnected circumstances for the preservation of organic bodies, and their subsequent disclosure. Amongst the most important of these are the habits and organization of the animals themselves. As in the case of birds, it might be predicated, that this lucky concurrence of circumstances would be rare with quadrumanous remains. The very perfection in the organization of the Monkey entails, as a consequence, that his solid frame should seldom continue to indicate the previous existence of the individual. His admirable agility and social habits protect him against most aggressions. A flood might suffocate in their dens, over a large tract of country, the burrowing tribes; and might sweep from under the feet of the monkey hundreds of its herbivorous and predaceous fellow-tenants of the forest, and bury them in the near shingle or far-distant estuary, or drown and deposit them in the stagnant swamp—while he would remain secure. The tree on which he was perched might totter, and yield to the undermining current, and he still escape and feed on his wonted fruits, undisturbed by the destruction around. When the debt of nature comes to be paid, his carcase falls to the ground, and immediately becomes the prey of the numerous predaceous scavengers of torrid regions, the Hyæna, the Chacal, and the Wolf. So speedily does this occur, that in India, where Monkeys occupy, in large societies, mango groves around villages, unmolested and cherished by man, the traces of casualties among them are so rarely seen, that the simple Hindoo believes that they bury their dead by night.

When the ancient races of India began to open upon us in the new forms and the exuberant variety which the fossils of the Sewalik Hills exhibit, we were early led to anticipate that some trace of quadrumanous animals would soon be met with to perfect a series, which would be incomplete without them. Several months ago we became possessed of a solitary specimen, which put the matter, in our own minds, beyond all doubt. We deferred making it public, however, in the hope of soon finding specimens of the cranium and teeth; being unwilling to rest the announcement on any thing less characteristic. That chance has since fallen to our fellow-labourers in the pursuit, Messrs. Baker and Durand, of the Bengal Engineers, who have lately discovered a specimen, consisting of a considerable portion of the face, and the whole series of molars

of one side, of a quadrumanous animal belonging to a much larger species than the bone we found.

Our fossil is the specimen which accompanies this communication. It is the astragalus of a right hind leg. It is completely mineralized, having a specific gravity of about 2·8, and it appears to be impregnated with hydrate of iron. Although but a solitary bone of the foot, the relations of structure are so fixed that the identity of the fossil is as certain as if the entire skeleton were before us. The very shallow excavation of the superior surface for the pulley-like articulation with the tibia; the form and extent of the lateral articulating surfaces for the external and internal malleoli; the considerable elongation of the apophysis for the head and neck of the bone; the slight obliquity with which it is sent off from the body; and the diagonal direction and form of the principal articulating surface with the calcaneum, are characters which, taken in conjunction, incontestably prove that the fossil is a quadrumanous astragalus. It would be needless, therefore, to dwell on the points of difference between it and the astragali of those orders of Mammalia which have an allied form. It is only requisite to ascertain how it agrees with the corresponding bone in existing species of Quadrumana. It closely resembles, in size and general form, the astragalus of the *Semnopithecus Entellus*, which we send along with the fossil for comparison.

The principal dimensions are as follow:—

Dimentions.	Sewalik Fossil Monkey.	*Semnopithecus Entellus.*
Extreme length of astragalus	1·3 inch.	1·35 inch.
Extreme width of body of astragalus	1· ——	1·03 ——
Length of body	0·8 ——	0·85 ——
Greatest diameter of navicular head	0·65 ——	0·65 ——
Thickness of ditto	0·45 ——	0·5 ——

The chief peculiarities of the fossil astragalus, compared with that of the Entellus, are these:—The upper articulating surface for the tibia is more convex than in the Entellus, and less square in the outline, the lateral margins approximating as they run backwards; the outer one being also more elevated. The peroneal articulation is precisely of the same form and extent as in the Entellus; and the rough fossa between it and the large calcanean surface also corresponds. The articular surface for the inner malleolus somewhat differs: in the fossil it is long, shallow, and rather pyriform in outline, while in the Entellus it is cup-shaped, deeper, and more extensive. The other pits and inequalities of the inner side correspond; but the entire surface slopes off more obliquely in the fossil. The great calcanean surface has the same

diagonal direction, with reference to the upper surface, as in the Entellus: it has also the same form, but it is more vaulted, and has less stretch and width. Its inner margin is bounded by the shallow, pulley-shaped fossa for the tendon of the *flexor pollicis longus* muscle, entirely as in the Entellus; and the rough pit between it and the anterior calcanean surface is alike in both. The head-and-neck apophysis is sent off as in the Entellus. The upper surface of the neck is narrower and less sloped. The scaphoid surface of the head is altogether less extensive. The head itself is not so thick and massive, and its long direction slopes more obliquely upwards than in the Entellus; its inferior articular surface is less, and there is a wide, rectagonal, rough gutter or fossa running half way across, so as to make two surfaces. In the Entellus the fossa is obsolete, and only indicated by a minute foramen, so that these articular surfaces run into one. This is the greatest difference observable in the fossil. The rough fossa at the outer side of the neck is alike in both.

With these inconsiderable peculiarities, the fossil agrees so closely in size and general form with the astragalus of the Entellus, that it probably belonged to the same sub-genus: still the points of difference are sufficient to leave no doubt, that the fossil must be assigned to a distinct species. In equalling the Entellus, it would belong to the larger Quadrumana. This is all the information the specimen conveys, regarding the animal from which it came; but we may hope to meet with remains, which will develope its entire osteology, more especially that of the cranium and face. The fossil was found by a party of Hindoo collectors employed by us on the fossil tract of the Sewalik Hills; and was brought to us mixed up with a promiscuous collection of the remains of the Hippopotamus, Mastodon, Ruminants, &c., like the specimens which have been sent to the Society. We have not therefore the means of knowing the exact locality where, and the circumstances under which, it was found.

The discovery is interesting in itself as supplying a deficient link in the series of the former tenants of the globe; but greatly more so in connexion with the races with which the fossil was associated. We have excavated from, or found in the debris of, different beds of the same formation which yielded the fossil astragalus, the remains of a species of Anoplotherium,* the *Crocodilus biporcatus* and *C.* (*Leptorhynchus*)

* *Anoplotherium Sivalense,* a new species, of a size somewhat larger than the *A. commune* of the Paris basin. The species is known to us by two upper jaws in our possession with the series of molars complete. We therefore quote it unhesitatingly.

Gangeticus,* respectively the Magar and Gavial, two species which at the present day inhabit the quiet waters of the Ganges. Here then are two most instructive facts: Quadrumana co-existed with a member of the oldest ascertained pachydermatous genus of Europe; and two reptiles now the contemporaries of man in the East, lived, and may have laved, in the same waters along with a species of one of the mammiferous genera which characterise the Eocene period of the West;—affording another illustration of constancy in the order of nature, of an identity of condition in the earth of the olden time with what it exhibits now, and of the invariableness of organized forms. The two decurrent ridges on the face which specifically distinguish the *C. biporcatus* of the present day, are as marked and distinct on the individuals which existed perhaps centuries of centuries ago; and an ankle bone of the Sewalik fossil Monkey so closely resembles that of a living species, that it is difficult to explain the difference.

The Sewalik fossils abound in monuments of this sort. There is a mixture of the new and of the old, of the past and of the present, of familiar with surprising forms, together with a numerical richness, such as no other explored region has exhibited within so comparatively limited a space. The Camel,† the Antelope, and Anoplotherium, have been found, intermixed with each other in the *same bed*. There are remains of the Elephant, Mastodon, Hippopotamus‡, Anthracotherium, Rhinoceros§, Hog, and Horse; the Tapir alone of the large existing Pachydermata being without a representative. In the Sivatherium‖ is seen a huge Ruminant exceeding in size the largest Rhinoceros; it is also armed with four enormous sheathed horns, divided and foliated like the Dicranocerine Antelopes, and able to contend for mastery with the Mastodon. Contrasted with him in the same family is the puny

* Known to us by specimens comprising the whole of the cranium and muzzle. They do not differ more from the existing individuals than these do from one another in varieties dependent on age and sex. Asiatic Researches, Vol. xix. Part II., Art. II.

† *Camelus Sivalensis* (Nob.), Asiatic Researches, Vol. xix. Part II., Art. X., a species of the size of the existing Camel.

‡ Asiatic Res., Art. III. *Hippopotamus Sivalensis* (Nob. & *H. dissimilis*, Nob.).

§ Journal of the Asiatic Society, Vol. iv. p. 706, and vol. v. p. 486.

‖ Asiatic Research. *ut supra*, Art. I. *Sivatherium Giganteum* (Nob.). Since the memoir was printed, Col. Colvin, Bengal Engineers, has got a specimen of the cranium with the bases of the four horns attached, and we have in our possession an almost entire rear horn, which has given the characters noted above.

Musk Deer, scarcely larger than a Hare. There are the Cat* and the Dog tribe, the Hyæna, Bear†, and Ratel‡, and other Carnivora. In the feathered races, there are Grallæ, greatly surpassing in size the Gigantic Crane of Bengal (*Ciconia Argala*). Among the Reptilia, besides the Magar and Gavial, there were other Crocodiles§ of enormous bulk, approaching the largest Saurians; and the Testudinata, which have hitherto held but a humble rank beside their Saurian co-ordinals, here show their giant representatives. In addition to numerous species of Emys and Trionyx not bigger than the small Terrapins of the sluggish brooks of Hindoostan, we possess humeri and femora of this tribe (with corresponding fragments of the bucklers) as large as the equivalent bones of the Indian Rhinoceros. As the Pterodactyle more than realized the most extravagant idea of the Winged Dragon, so does this huge Tortoise come up to the lofty conceptions of Hindoo mythology: and could we but recall the monsters to life, it were not difficult to imagine an Elephant supported on its back.

VIII.—*Memoir on the Geology of Cutch.*‖—*By* C. W. Grant, Esq., *Capt. Bombay Engineers.*

Geographical Position, and Physical Aspect.

The province of Cutch, in the East Indies, is situated between the 22° and 24° of north latitude, and 68° and 70° of east longitude. It is bounded to the north by the Grand Runn, beyond which is the Thur or Little Desert; to the S. W. and S. by the Gulf of Cutch and the Indian Ocean; to the E. and S.E. by the district of Guzerat; and to the N. W. by the eastern branch of the Indus and the territory of Sinde. Its extreme length from E. to W. is about 180 English miles, and its extreme breadth is 50 miles; but in one place it is not more than 15 miles across. It contains about 6500 square miles, independently of the

* Asiatic Researches, Art. XI. *Felis cristata* (Nob.). Smaller than the Tiger.

† *Ibid.* Art. XII. *Ursus Sivalensis* (Nob.). Size of the *U. Spelæus.*

‡ Messrs. Baker and Durand, Journal Asiatic Society, Vol. v. p. 581.

§ *C. Leptorhynchus crassidens* (Nob.), an immense species far exceeding existing ones, and forming a passage from the Gavials into the true Crocodiles. It has the cylindrical muzzle and synostorized lower jaw of the former with the blunt thick teeth of the latter.

‖ From the *Transactions of the Geological Society of London,* Second Series, Vol. v.

Grand Runn, which ought, however, to be considered as a part of the province, and which, including the islands with the portion bounded by the Guzerat coast, occupies an area of at least 9000 square miles.

Physical Aspect of the Country.—The province is hilly and rocky, with the exception of the part forming the southern coast, which is a dead flat covered with a fine rich soil. Three distinct ranges of hills, having an easterly and westerly direction, may be traced. The most northern forms an irregular chain bordering the Runn, and, for the greater part, presents to the north a perpendicular cliff surmounting a sloping talus, and to the south an inclined plane. It is composed chiefly of rocks, containing marine remains. The next, called the Charwar range, passes transversely through the centre of the province, and is connected with the former, at its north-western extremity, by a cluster of hills. It consists partly of sandstone containing beds of coal, and partly of a series of strata of slate clay, limestone slate, and slaty sandstone. The third, or southern range, and composed entirely of volcanic materials, has the same direction as the other two ; but it is of smaller extent, and a branch of it, striking nearly north and south, passes through the centre of the Charwar range. A number of isolated volcanic hills are also scattered over the plain and in other parts of the province, particularly on the borders of the Runn, where is situated the hill called Denodur, the largest in Cutch.

There are no constant streams, the river courses being merely channels for conveying the periodical floods to the sea, and containing, during the remainder of the year, only detached pools. The banks of these courses are, however, very high and precipitous, and afford excellent sections of the strata through which they pass.

Formations.

I have divided the country into the following eight distinct formations :—

1. Syenite and quartz rock.
2. Sandstone and clay, with beds of coal.
3. Red sandstone.—This formation I have been unable to trace the boundaries of. In mineralogical characters it resembles the new red sandstone of England, and differs materially from No. 2., or the formation which contains the coal.
4. Upper secondary formation, consisting of slate clay, limestone slate, and slaty sandstone, and containing *Ammonites*, with other fossils characteristic of the secondary formations of Europe.

5. Nummulitic limestone and marl.
6. Tertiary strata.
7. Alluvial, or recent deposits.
8. Volcanic and trappean rocks, including all such as bear evident marks of a perfectly igneous origin, as basalt, &c.

These eight divisions, considering the red sandstone as one, represent generally the geological structure of the province, though many minor subdivisions might doubtlessly be made.

1. Syenite and Quartz Rock.

The only good example of syenite *en masse* is a hill called Calunja, near the town of Nuggur in Parkur, a district in the Thur, and not far from the mouth of the Loonee river. It is not in Cutch Proper ; but as it forms part of the northern coast of the Runn, and is in other respects connected with the geology of the province, I have introduced it as one of the formations.

The Calunja hill is a confused heap of light red syenitic rocks, composed of quartz, red or white felspar, and large long crystals of hornblende ; the compound being sometimes coarsely grained, and sometimes finely. The base of the main hill is surrounded with small conical mounds, which, at a distance, resemble the huts of a village. On entering the space occupied by these mounds, the hill presents a number of irregular, shattered masses, the sides of which are so steep, and are worn so smooth by the action of the elements, as to be extremely difficult of access. Between these masses the sand lies very deep. It is quite evident, that this hill has been violently acted upon by earthquakes.

In the bed of a river near the village of Koonerea, in the Puchum island, situated in the Grand Runn, I found some masses of precisely similar syenite, which were probably erratic blocks from the Calunja hill ; this island lies nearly in the direction which would be taken by any sudden floods, coming down the Loonee river.

Quartz Rock.—This rock is principally developed in a hill of considerable height near the town of Mhurr, situated towards the western side of the province. The upper part of the hill is entirely composed of it, and huge masses are scattered about the base. A large cleft extends about half way up the western face of the hill, and displays its internal structure, consisting of a centre of quartz rock, surrounded by horizontal strata of loose, quartzose sandstone. The quartz rock varies considerably in character, being sometimes perfectly compact, exceedingly hard,

conchoidal in its fracture, and smooth or foliated on the surface; in other parts it is saccharoidal; occasionally it consists of larger particles, so firmly cemented together that they break with smooth surfaces: some masses, again, have a decidedly granular texture; and one variety is composed of rounded pebbles of quartz of the size of marbles; but in no specimen did I find any other material than pure quartz.

From the extremely fractured appearance of this hill, and from the quantities of basalt lying about, and forming the principal part of some small hills immediately adjoining it, there can be no doubt that it has been subjected to igneous influence; and to the same cause the variety in the texture of the quartz is also probably due, some portions appearing to have been sufficently fused, for its particles to have agglutinated into a solid mass. This opinion may perhaps be further strengthened by an examination of the country near the town of Mhurr, distant about one mile and a half, where various dykes of basalt traverse the strata. Similar intermixtures of quartz with basalt occur in a hill called Peaka, from its piebald appearance, not far from Joorun, on the Runn, and nearly opposite the south-west extremity of the Bunnee: also in some low hillocks at the base of the Katrore hill in the Charwar range. At the village of Ghuranee, about ten miles east of Mhurr, a large dyke or vein of quartz protrudes from a level plain, and forms a ridge of solid rock about 30 feet in height. Basalt also crops out near the same spot.

2. Sandstone and Clay, with Beds of Coal.

This formation occupies a considerable portion of the country, and consists of a regularly stratified series of thick beds of sandstone, alternating with slate-clay, which contains, occasionally, bands of ironstone; and where the coal occurs, it is intermixed with blue clay or shale, and a greasy substance resembling fullers'-earth. South of the Charwar range, the general dip of the strata is S. by W. and S. W., at about one foot in twenty or thirty; but north of that range, the dip varies so much, that it is impossible to ascertain the prevailing direction; and the whole series is so broken, and intersected with dykes and dislocations, as to render fruitless all attempts to determine its general strike.

The centre of the province is dotted with hills containing igneous rocks; and the disturbed state of the beds, in their vicinity, may easily be conceived. The smaller hills are composed of confused heaps of a very ferruginous sandstone and ironstone, belonging to this formation, and the surface soil is a deep sand. The

texture of the strata varies from a coarse, loose sandstone to a compact and extremely hard quartzose grit and conglomerate, cemented by ferruginous matter, some specimens being almost black.

Iron Ore.—In this formation, the iron ore smelted for commerce is procured. It is found in different parts of the country, but has been principally extracted near the town of Doodye, opposite the S. W. termination of the Bunnee. It there occurs in small lumps, which are of a spongiform texture, small specific gravity, and are very frangible. The natives, however, value this variety more than the heavier, from its yielding with greater ease to their imperfect means of smelting.

Manufacture of Iron.—In extracting the metal, layers of very small pieces are disposed alternately with others of charcoal, in a rude open furnace, and exposed to the blast of two small bellows made of sheep-skins. The metal, when fused, falls into a hole at the bottom of the furnace, whence it is transferred to an inclosed furnace, and subjected to similar blasts, until brought to a white heat, when it is taken out and beaten into a bar. No flux of any kind is used. A considerable quantity of iron was, at one time, made from a totally different description of ore, found near the village of Punundrow, in a plain which extends to the sea or eastern mouth of the Indus. This plain is bounded to the south by low hills covered with fragments of basalt, being outliers of a basaltic range further to the south-east. The surface of the plain is composed of a fine smooth gravel, composed of comminuted particles of iron ore, and has every appearance of having been, at no distant period, covered with water. The iron ore is found near the surface of the low hills above mentioned, in small tabular fragments imbedded in a purple-coloured earth ; and those pieces are selected, which give a bright streak on being struck by a pointed instrument. Externally the ore is of a purple colour, and internally presents small dark blue fibres, arranged at right angles to the surface of the specimen. In another place a variety occurs, which resembles small fragments of tile, but has the same internal structure. It is very hard, and of considerable specific gravity ; and is said by the natives to have yielded a much greater per centage and much better iron than the ore found at Doodye ; but the manufacture of it has been suspended, owing partly to the scarcity of fuel, and partly to English iron being procured at a cheaper rate, as well as in much more convenient forms.

Coal.—Coal has been found in this formation in various places, but not in beds sufficiently thick to be worth working. It was first dis-

covered in the bank of a river near the city of Bhooj, forming a bed about 18 inches thick, and associated with strata of sandstone and blue clay, the dip being, to the eastward, one foot in twenty. This bed was worked for some time, and considerable quantities of its produce were sent to Bombay, but the quality was bad, being very slaty, and containing a large proportion of incombustible matter. Attempts were afterwards made to discover coal in other parts of the province; and although various beds were met with, they were too thin to be of any value. This search was carried on principally to the south of the Charwar range, a few miles from the town and fort of Seesaghud. One bed was found of a very good quality, but only 9 inches thick. It consisted of masses composed of small cubical pieces, which soiled the fingers very much, had not the slightest appearance of a lignite, and ignited quickly, burning with a bright flame, and leaving a small residuum, but it would not cake. It was found on trial to get up the steam of an engine-boiler very well and quickly, but a much larger quantity was required than of English coal, owing, partly, to its breaking into so small fragments as to fall through the bars of the grate.

Borings for Coal.—A boring for coal was made near this bed; and although 270 feet of sandstone and blue clay were penetrated, no coal was found. A similar attempt was made six miles further to the eastward, and to the depth of 191 feet, but with no better success; and similar researches were made in one or two other places. The second trial passed through a regularly alternating series of sandstone and blue clay. Some of the sandstones were so extremely hard (being composed of quartzose particles cemented by ferruginous matter) as to be almost impenetrable. A jumper, worked by a lever-bar, making eighteen strokes in a minute, penetrated, after eight hours' work only, from 1½ to 2 inches. Other specimens of sandstone varied both in hardness and quality; and at a depth of 190 feet, a bed of white, pure quartzose sand was entered, when water immediately rushed to the surface, and continued to flow in such quantities as to stop the work. The shale was of a very dark blue when first brought up, but it lost the greater part of its colour after exposure to the sun. Iron ore and iron pyrites were found. All the banks of the rivers in the neighbourhood present strata of sandstone and slate-clay, with bands of ironstone, and, in places, thin beds of coal. The general dip is, to the south-west, about one foot in twenty; but the strata are greatly shattered and dislocated by dykes, slips, and hitches.

Vegetable Impressions.—The slate-clay, and, in some cases, the sandstone, contained numerous impressions of ferns and reeds, occa-

sionally of a large size. One specimen, which was flattened, was four inches in breadth, and the outer surface was carbonised, but the interior was filled with sand: this was generally the case, though other specimens were carbonised throughout, and some were mere impressions. In digging wells within the limits in which they occur, coal was frequently found, but always in thin beds; and some of it ought more properly to be called lignite.

Extent of Coal-field.—The coal-field, if it may so be termed, is bounded to the north by the upper secondary or laminated slate-clay and limestone slate formation; and to the south it is cut off abruptly by a low range of volcanic and trap hills. I could not ascertain whether it had ever been covered by any conformable, stratified deposits. Thin beds of coal have been found in various other parts of the formation. The general structure of this series of strata, the quality of some of the coal, the nature of the sandstone and slate-clay, the impressions and remains of reeds, ferns, &c., the bands of ironstone, the dislocations by dykes, slips, &c., all bear an analogy to the coal-fields of England; but I am inclined, from the vegetable remains, to consider this deposit an equivalent of the oolitic coal of England, and not of the regular carboniferous system.

Alum Works near Mhurr.

The ground on which Mhurr is built, consists of high, irregular banks of marl of every variety of colour, but in a most confused and shattered state. It is surrounded on three sides by steep hills, forming a kind of amphitheatre; and nothing can be more desolate than its appearance. North of the town is a high table-land, which extends to some hills about one mile and a half distant. It is composed, near their base, of a ferruginous quartzose sandstone, on which the variegated marls rest; the latter being covered, in many places, with a bed of coarse gravelly detritus, six or eight feet thick. Imbedded in this gravel, are some very large masses of basalt, and of a very hard, black stone, composed of grains of quartz cemented by an almost black oxide. They are cut into mill-stones for grinding flour. The whole are evidently boulders from the hills to the northward, which were mentioned in the first part of this memoir, as consisting of quartz and basalt. This plain terminates, to the southward, in a high bank overlooking the town, and intersected in one part by a large dyke of spheroidal basalt, which has apparently so indurated the strata of variegated marl in its vicinity, as to permit them to be

quarried for building. A large quantity of alum is made at this place, and exported to different parts of India.

Manufacture.—The shale from which alum is obtained, forms beds in the variegated marl; and in a kind of blue clay. Long galleries are cut for the purpose of extracting it; but so plentiful is the supply, that no means are taken to support them, and they generally fall in during the rainy season. The manner in which the alum is prepared is very simple. The earth is exposed in heaps to the sun and air for about five months, during which it burns spontaneously. It is next laid out in little beds similar to those of a field prepared for irrigation, and it is watered by a small stream for ten or fifteen days, by which time the aluminous matter accumulates into semi-crystalline plates. This substance is boiled in water for about seven hours; after which, a third, or one half, by weight, of potash is added, and it is again boiled for a few hours, according to the strength of the ley. It is then poured into large open vessels, where, after settling for some time, it is washed, and the liquid drawn off, leaving an impure crystalline sediment. This is once more boiled, and when it arrives at a proper state, which is learned by practice, it is poured into large earthen vessels with a small mouth, and sunk into the ground to prevent their breaking. After a time, the vessels are dug out, broken to pieces, and a lump of pure alum extracted. Six or eight measures, by weight, of alum, are produced from ten measures of the substance from the irrigating beds, and four or five measures of potash. It is not so much esteemed in the Bombay market as that brought from China, on account of its yellow tinge.

Some of the marls resemble chalk, being white, and soiling the fingers; and some are very calcareous, whilst other varieties scarcely effervesce with diluted muriatic acid. In one mass I found a very minute specimen of *Buccinum pumilum.* These marls also occur of every variety of colour as well as texture; some of them consisting of innumerable thin laminæ curiously twisted and arranged in the most intricate manner; and others of a kind of breccia, composed of small broken portions of marls. Several dykes of basalt cut through these beds; the whole presenting a most confused assemblage, partly due to natural causes, and partly to the numerous mines which have fallen in. One of the banks has been burning spontaneously for several years, in a similar manner to that at Ruttrea, and apparently from the same cause. The exact geological position of these marls I could not determine.

3. Red Sandstone.

I have mentioned a red sandstone formation, which may be described now. It occurs to the southward of the coal series, and is separated from it by a low range of hills about six miles broad, composed partly of basaltic rocks, and partly of a variety of porphyry. This sandstone is regularly stratified, and has the same dip and inclination as the sandstone and coal series, but differs very materially from it, in being much softer, generally finer-grained, of a vast variety of colours, and by containing no organic remains. Associated with the sandstone are beds of clay, varying in colour from purple to deep red. One of the beds is aluminous, and has been burning spontaneously for a long period. The smoke issues from a deep crevice in the bank, and the fumes are highly sulphureous. A stick thrust into the crevice soon ignites, and the whole bank has a burnt appearance; the red clay, which rests immediately upon the stratum, having been converted into a perfect brick, and the other variegated clays having been variously acted on. Although this bed would yield a large per centage of sulphate of alumina, it has never been worked. The strata dip at an acute angle to the south, and are covered, in that direction, by beds of gravel, succeeded by others of sand and soil, which extend to the sea.

4. Laminated Series or Upper Secondary Formation.

Alternating strata of slate-clay, limestone-slate, and occasionally slaty sandstone, constitute this formation. The more calcareous beds are very hard and compact, whilst some of the others are very earthy and friable. In many of the calcareous slabs, the upper and under surfaces are argillaceous, hard, and compact, but the centre is a grey limestone, which takes a good polish, and might be used for lithography. The slate-clay is of a dark blue colour, and generally peels in thin flakes, leaving a flat, lenticular nodule or centre. In many places, vast thickness of this laminated slate-clay occur without the least admixture of the sandstone-slate, whilst in others, the latter alternates very often with it.

The beds being horizontal, except where they have been disturbed, the formation occupies considerable tracts; and where it rises into hills it is generally capped by a thick bed either of coarse, soft sandstone, as in the ghâts of the Charwar range, the Bhooda hill (near Bhooj), the Jarra (near the Indus), and other hills; or of a very compact, hard, crystalline sandstone, with a conchoidal fracture, as in the Chuppal hills, the Jarra, and in other places, including the natural walls of the Runn, described in a subsequent part.

Relative Position with respect to the other Strata.—I searched diligently to find the relative position of this formation distinctly defined, but in vain, as, at its apparent junction with other beds, the whole of the strata were broken up, and so confused as to baffle every attempt to ascertain the boundary. I am induced, however, to believe that it occupies hollows in the sandstone and coal formation, or abuts against it. It cannot underlie that series, because its strata are always *horizontal*, except where locally disturbed ; while the beds of sandstone and coal are as invariably inclined at a considerable angle, and are everywhere intersected with dykes, slips, and other dislocations, from which the upper secondary strata are generally free. In one instance the formation evidently occupied a hollow in the coal sandstone.

In many places it appears to abut against the sandstone, occupying large tracts which may, at some period, have been covered by beds of that formation, subsequently washed away. From what has been stated above, it is at all events newer than the coal beds ; and this conclusion is also borne out by its imbedded fossils.

Apparent Position with respect to the English Series.—In its mineralogical character and general appearance, this formation greatly resembles the English lias ; but its fossils have been found, after a careful examination by Mr. James Sowerby, to assimilate very closely to those of the oolitic beds ; and a very few belonging to the green sand.

Fossils.—Of the fossils found in these beds, the Ammonites are the most characteristic, occurring in vast quantities, particularly in some hills bordering the Runn. Of the eleven species which I collected, eight are unknown to Mr. James Sowerby, to whom I am entirely indebted for all my information regarding them. Of the other three species, one so closely agrees with *A. Herveyii* of the English cornbrash, that he is induced to consider it only a variety of that species ; another in the outer whorl resembles *A. perarmatus* of the coral rag, but differs in the structure of the inner whorls ; and the third, of which there is only one imperfect specimen, is like *A corrugatus* of the inferior oolite of England. They generally vary in diameter, from three to five inches : the largest I found being eight inches. It was imbedded in a mass of gold-coloured oolite. The genus next abundant is the Terebratula. Of the seven species collected by me, five bear so close an analogy to the *T. biplicata*, *T. dimidiata*, *T. sella*, *T. intermedia*, and *T. concinna* of the green sand and oolitic series, that it has been found impossible to consider them distinct species. The Trigonias are numerous, though con-

fined to two species, one of which differs so very little from *T. costata* of the lower oolites of England, that Mr. Sowerby considers it only a variety of that fossil. The genus *Pholadomya* also abounds, but the specimens are generally broken. Of the three species I collected, Mr. Sowerby has not been able to establish an identity with any known Pholadomya in England, although there is a general resemblance to the oolitic and lias fossils. I found two species of Belemnites, one of which resembles *B. canaliculatus* of the inferior oolite; the other is not determinable. Of the species of oysters, one resembles the *Ostrea Marshii* of the English cornbrash. I found it in a bank high up the Katrore hill, in the Charwar range, in friable, laminated strata of slate-clay and sandstone slate, associated with Ammonites of the same description as those at Charee and along the Runn*. I did not find a single specimen of a Gryphæa, although numbers of the genus have been collected from this province. Some crinoidal stems, which I collected from the same localities resemble those of a species found in the mountain limestone; but as the fossils above enumerated characterize the middle series of the English upper secondary rocks, fossils belonging to so much older a formation can hardly be associated with them. These crinoidal remains, therefore, probably belong to an undescribed species. The only fossil bone which I discovered, Messrs. Clift and Owen consider to be a caudal vertebra of a Saurian. This determination is, however, very interesting, as it shows how widely these animals were distributed; being, in this distant country, also associated with the same mollusca (one valve of a *Trigonia costata* is imbedded in the mass containing the bone) as accompany their remains in the English strata.

In the Appendix to this paper I have given a complete and systematic list of all these fossils, stating the localities where I collected them.

General Shape of the Hills belonging to this Formation.—Many of the hills in Cutch present, on the north side, a perpendicular cliff surmounting a sloping talus, and on the south an inclined plane; and they owe this peculiar outline to their being composed of a base of laminated clay or sandstone, capped by a thick bed of coarse and brittle sandstone. This is particularly the case in the Jarra hill, and the hills of Hubbye, Lodye, and Roha-ké-Koss, near the village of Joorun, on the Runn; also those of the Puchum and Khureer islands in the Runn, particularly the

* At the base of these hills, and forming the immediate borders of the Runn, fossil shells are found of a very different description, among which I may enumerate *Cardium*, *Pecten*, *Corbula*, *Venus*, *Globulus*, and vast quantities of *Turritella*; which last form large masses of rock protruding every here and there above the bed of the Runn.

latter ; likewise those near Beyla, at the north-eastern extremity of the province, and many others The Katrore hill, forming the eastern extremity of the Charwar range, belongs to this formation, and, therefore, differs materially from the greater part of the range, which is composed principally of sandstone, except in the portion opposite Bhooj, where this laminated series also occurs. The strata being principally horizontal, the hills have a conical form.

It is a curious circumstance, that, in the same group, some of the hills of the laminated strata have a thick capping of sandstone, whilst an immediately adjoining peak, of equal height, has none. I conceive the thick beds of the sandstone once covered the whole surface, and that on their upheavement they broke into masses, which have been since denuded from some of the hills, the debris forming the deep sandy plain around Bhooj.

In the hill of Jogé-ki-bit, near Nurra, on the Runn, the beds dip from 40° to 50° to the north, and alternate three times with basalt. The strata vary greatly in character, some of them being very hard and crystalline, particularly those containing calcareous matter ; whilst other parts of the series, immediately adjoining, are very friable and earthy. Some of the schists assume the character of a roofing-slate, and others are only soft, laminated blue clay.

A cluster of hills, occupying a surface of three or four square miles to the north-west of the city of Bhooj, called the Bhoodha hills, also belongs to this formation, being composed of slate-clay, tabular sandstone, and limestone slate, in many parts assuming a very friable, earthy texture, and frequently capped with thick beds of coarse, soft sandstone. The strata are often horizontal ; in which case the hills are conical ; but in many instances the beds incline at a considerable angle ; and the hills assume, when capped by the sandstone, the usual form of an abrupt escarpment, with a long inclined opposite side. They are intersected by numerous ravines and nullahs ; the looseness of the soil, and peculiar tabular construction of the strata, offering a very slight resistance to the action of the rains. The Chuppal hills, between Guranee and Nurra, in the north-western division of the province, afford another example of the elevation of these strata into hills. They consist of beds of a very earthy and friable description, covered by a thick stratum of hard crystalline sandstone, slightly calcareous ; and the lower part forming a sloping talus, capped by the hard rock, in masses 20 feet thick ; they appear as if they were surmounted by old ruins or turrets.

Manner in which the Hills have been formed.—From an attentive examination of these hills, I am led to infer, that they have all been uplift-

ed by a movement which proceeded from below; the laminated series having yeilded to the upheaving power, and the loose brittle sandstone having broken off abruptly. That this has been the case with the minor ridges, and what I may term the *natural walls* in the Runn, described in treating upon that district, there can be no doubt, as I have found them at angles, varying from a few degrees above the horizontal position to the vertical, and even turned over beyond that point.

That these beds have been disturbed and broken through by igneous agents is quite evident from the dykes of basalt, which occasionally intersect them.

5. Nummulitic Limestone and Marl.

Although the imbedded fossils of the Nummulitic group resemble those of some tertiary beds of England and France, still the strata of which it consists, differ so totally in mineralogical character and general appearance from any of the other formations in Cutch, that it deserves a separate notice. It is bounded partly by the second or sandstone and coal formation, partly by beds which I have named tertiary, and partly by the alluvial banks of the eastern branch of the Indus, extending from Luckput to a plain between the villages of Wagé-ké-Pudda and Eyeraio, about thirty miles to the southward. It consists of a mass of small Nummulites mixed with Fasciolites; and some of the river banks present a perpendicular section of solid rock, from 60 to 70 feet in height, entirely composed of these small fossils agglutinated together, and varied only by a species of Orbitolites, frequently bent into a saddle shape. This stone has much the appearance of chalk, and the beds are horizontal, except where they have been disturbed. In some parts, however, it is much harder, particularly near the town of Luckput, where it is quarried as a building stone, and is also burnt for lime. The surface-soil is entirely composed of the small fossils lying loose, and generally known by the name of Luckput sixpences.

The beds of nummulitic limestone on which Luckput stands have been affected in a manner deserving of notice.

The high ground to the east of the town sends off three parallel ridges to the westward, ranging nearly east and west. On the two northernmost of these ridges, the north and south walls of the fort of Luckput are built; whilst the southernmost lies at a distance of about 200 yards from the south wall. A kind of valley runs through the town, ending, at its western side, in a swamp, which is crossed by the western wall of the fort. A cut through the northern ridge exposes a very good section of the nummulitic stone, dipping 40° to the north; whilst, in a similar cut

through the southern ridge, made for the purpose of connecting two tanks, the same beds dip from 40° to 50° due south. In the centre ridge the section is not quite so perfect, but the beds are nearly, if not truly, horizontal, forming an anticlinal axis to the other two.

This elevated tract of the nummulitic limestone extends only three miles to the eastward of Luckput, the ground there descending abruptly into a plain, composed of various clays, a coarse ferruginous stone and sandstone, with quantities of selenite scattered about, the whole presenting a confused appearance, as if it had been the site of an igneous outburst. Patches of ground, every here and there, have also an altered appearance, and are covered with small fragments of igneous rock. The plain is bounded to the south by a low range of basaltic hills. From Luckput southward to the village of Punundrow, the same nummulitic rock continues, but varies in hardness from a compact limestone to a white marl. It is also very well exposed between the villages of Eyeraio and Wagè-ké-Pudda, at the southern limits of the formation. To the S. W. of Eyeraio is a plain, composed of a white calcareous marl, and flanked to the south by a low range of hills of the same material, sending off into the plain numerous small projections, with rounded terminations precisely like headlands. Numerous isolated hillocks, or high banks, with sides worn in the same way, and resembling islands, are scattered about the plain, and the whole surface looks as if it had only lately been deserted by water, or as if a violent flood had swept over it. The banks of the small nullahs, which intersect the plain, are composed of gravel, containing rounded masses of a variety of the calcareous marl. Advancing westward, the ground rises a little, and the surface consists of a hard rock, which contains oysters and other bivalves, whilst in some places large patches are entirely composed of silicified corals. I also found in this place fragments of fossil bone, said by Messrs. Clift and Owen to be parts of rib-bones, like those of the *Manatus*, but flatter. To the north, this plain is bounded by a river, the perpendicular banks of which, 60 or 70 feet in height, consist entirely of nummulitic marl, capped by a thin stratum of gravel. In one part, the bed of the river is subjected to the action of a small stream of water, so strongly impregnated with saline ingredients, that large lumps of salt are formed in the hollows worn in the rock, which here assumes the character of a hard limestone, probably in part due to the quality of the water that passes over it. The beds are horizontal, except where they have been disturbed and shattered.

Characteristic Fossils.—The most characteristic fossils of this formation, next to the Nummulites and Fasciolites, are Echini, Galerites,

Clypeasters, and Spatangi. The species of Echini and Galerites are all new. A Clypeaster resembles *C. affinis* of the sandy marl of Brabant; and a Spatangus, the *S. Bucklandii* of the marly chalk of Westphalia; while another species agrees with the *Spatangus acuminatus* of the tertiary deposits of Dusseldorf. The other fossils consist of species of Tellina, Astarte, Cardium, Arca, Pectunculus, Pecten, Nucula, Ostrea, Cerithium, Turbinellus, Globulus, and Seraphe. The Turbinella abounds and is often very large. In the bed of the river above described, I found large blocks composed entirely of small oysters, similar to *Ostrea Flabellulum*, but more regularly and finely striated.

6. Tertiary Strata.

I have called all that portion of the province *tertiary* which is composed of rocks containing fossils belonging to this period. It consists principally of a hard argillaceous grit, interspersed with fossil shells, and covered by beds of pebbles or conglomerate. Some portions of this conglomerate are very coarse, and constituted of rolled or boulder stones loosely connected; whilst other portions are sufficiently indurated to be used as a building stone. A calcareous grit, which soils the fingers like chalk, also occurs in patches, and contains innumerable small shells. It is used for building, and is burnt for lime. The beds are horizontal, and the surface of the country is generally covered with a fine rich soil

At the village of Soomrow, about ten miles north-east of the fort and harbour of Juckow, on the south-western coast, the banks of a broad river-bed are composed partly of a loose gravelly soil, and partly of a very hard, compact, calcareous rock, full of shells, and burnt for lime; and below this rock is a coralline limestone. The river-bed, in some places, is nearly a mile across, the banks being cut into ledges or steps, whilst numerous small hillocks, or high banks of gravel and clay, stand isolated in its middle. Only a small stream now winds from shore to shore. One part of the northern bank rises into a small hill, the surface of which is composed of the same hard, compact, shelly rock as that which is found even with the bed of the river. For some distance north of this spot, the ground is also high, and cut into innumerable ravines; and there are breaks in the surface, as well as circular hollows, or large, deep pits. The natives have a tradition, that an earthquake occurred at this spot, some centuries since, during a severe battle between the Sindians and the natives of Cutch. The raised position of the shelly rock, and the peculiarly rent and broken appearance of the ground, indicate some convulsive movement; and it should be noticed, that, as all the

beds are horizontal, those forming the hill cannot be an unbroken continuation of those in the banks of the river.

This formation continues a few miles further to the northward, where it abuts against the nummulitic beds.

In many places towards its northern limits, it rises into hills, and considerable tracts of high, undulating country; the loftier portions consisting invariably of hard, shelly rock, including large patches, of one or two acres in extent, of silicified corals; and the lower parts, or intervening spaces, of a loose gravel or clay, equally full of organic remains. Some parts of this district, particularly that near the village of Kotra, have a very remarkable appearance, as if they had been subjected to a violent flood, which had washed away the surface-soil to a depth of 30 or 40 feet, leaving a broad, shallow valley, two or three miles across, with numerous isolated and rounded bluff hills of gravel, scattered about its bed. The banks, or bounding lines, consist of low hills, cut into innumerable small ravines; the whole being composed of the same shelly rock, and gravel, and clay as above described.

The fossil shells found in this district occur often in beds, consisting of a single species. One of the hillocks, above described, is about 60 yards long by 20 broad, and 15 feet in height, and is entirely covered with *Ostrea callifera*, lying loosely on a gravelly soil, or cemented into a solid rock. The highest part of the table-land in one place, near the village of Kotra, is also composed solely of oysters, forming a very hard rock or limestone; other isolated banks are completely covered with what appears to be a species of large Serpula, or else fragments of coral. Numerous other fossils are found, either lying loose or imbedded in the rock, and consist of species of Lucina, Venus, Cardium, Pecten, Ostrea, Turritella, and Clypeaster. The Turritellæ are imperfect, but particularly numerous.

This flat valley or broad river-bed (for a small stream still winds through it,) continues to the hills surrounding the town of Mhurr, spreading, in places, into lake-basins, all of the same description as above detailed; but, a short distance south of the Mhurr hills, its course is cut across by a dyke of very compact basalt, of perfectly columnar structure; each face of the polygons being about two feet in breadth. This basalt forms both banks of the river for 50 or 60 yards, and to the height of 20 or 25 feet; the bed of the river being also formed of sections of the columns. The clay through which the basalt passes is hard, and of a brick red; and quantities of iron ore, of a spongiform texture, are scattered about.

The southern base of the Mhurr hills is now approached, and presents a most confused appearance, the country at their foot being shattered in all directions. It is impossible to conceive ground in a more disturbed state. The banks and ridges, varying from 20 to 60 feet in height, are partly composed of a coarse, calcareous grit, full of the marine shells already enumerated, and partly of a blood-red coloured clay, which has apparently been altered by a trap dyke. One bank exposes a section, 60 to 70 feet high, of horizontal layers of gravel, clay, shelly rock, and iron clay, which in one spot appear to have fallen in bodily, dipping abruptly from both sides to a point.

Fossils.—The principal deposit of fossil shells which came under my inspection, was at the village of Soomrow, just described. The specimens which I collected have been examined by Mr. James Sowerby, and found to consist of 33 known genera. Of the 57 species belonging to these genera, 47 are new, 6 are known, and 4 are doubtful. The most numerous among the univalves belong to the genera Mitra and Voluta: there are also great quantities of the genera Cerithium and Terebra; some of the latter being very beautifully marked. The genera Solarium, Conus, and Strombus also abound. Among the bivalves, the Pectens are most numerous; and among the Radiata, are great numbers of Clypeaster. Most of the fossils which I collected, either lay closely on the gravelly bank, or were cemented into large tabular slabs of rock.

I was informed by the natives, that, about the year 1834, great quantities of large fossil shells, called by the country people *Sonk* or *Conk*, being a species of Turbinella, were found in a land-crack, in a field about two miles from this spot; and so perfect, that they were given to the priests of the different temples in the neighbourhood, who, by inserting a metal tube into the apex of the shell, converted them into horns, to call the devout to prayer. I could not, however, find any when I visited the spot, the crack having been filled up by subsequent floods.

Extent of the Tertiary Formation.—These tertiary beds reach, in one place, to the town of Mhurr, a distance of thirty miles from the sea, and extend in a belt of, perhaps, a third of that breadth, throughout the whole southern coast of the province. A narrow line should also be drawn along the borders of the Runn, and around the islands in it, as the fossils, found on the immediate shores, belong to the tertiary period.

7. Alluvial, or Recent Deposits.

These consist entirely of plains covered with soil, evidently detritus which has been washed from the hills, or of land recovered from the sea by the blowing up of sand. The whole of the province south of the volcanic range might be considered alluvial; the surface being composed of a thick soil, formed by the rapid decomposition of the basaltic or igneous hills; but as the banks of the rivers contain tertiary shells, I have thought it better to designate the district as consisting of rocks of that age. The boundary between the tertiary and alluvial districts must, therefore, be considered partly imaginary, as I have thought it more correct to give a general outline, than to mark, with apparent minuteness, limits, which my examination of the district, did not enable me to ascertain.

Land gaining on the Sea.—In many places along the coast, where there are ridges of sand, the land gains upon the sea. These dunes are constantly increasing, from the particles blown up by the sea-breezes, or the south-west winds, which prevail during so great a portion of the year; and the ridges frequently occur in double rows, occupying a considerable breadth, and varying from 50 to 100 feet in height. During strong winds the whole appear to be in motion, from the sand drifting along their surfaces.

At Mandavee, the principal seaport in Cutch, is a ruin on a spot called the Old Bunder, or Quay. It is now about three miles inland, and is situated on the bank of the river, which flows into the sea near the present town; but at the time when this old quay was in use, the town must have been some distance from the present shore. A small temple, built upon a rock, now in the middle of the town. is said to have been at that time also in the sea. Even now, a considerable space, composed of loose sand and sand-hills, intervenes between the town and the sea; and the distance is continually increasing, owing to the quantity of sandy detritus brought down by the river during the periodical floods, and washed back by the sea in the dry season. A bar is also thus formed across the mouth of the river, and the position of it varies so much, and so often, as to render the entrance to the river very difficult. Even boatmen belonging to the port, who have been absent a few months, cannot pilot their vessels in. During very dry seasons, this bar increases to so great a degree as almost to block up the entrance entirely; and the laden boats always strand upon it at high water, their cargoes being carried away by carts, when the tide is out.

At Moondrah, Budraseer, and other seaports up the Gulf of Cutch, the

land also gains upon the sea, rendering necessary the frequent removal further seaward, of the quays or landing-places. Where rivers enter the gulf, this increase of land at their mouths is easily understood, as the sea, for nine months of the year, washes back the sandy detritus accumulated by the river at its delta during the periodical floods. Where rivers flow all the year round, they may be enabled to keep a channel through the deltas constantly free ; but when the stream is inert during three fourths of the year, and the wind and sea are continually at work, the case must be very different.

Marine Forests.—The same operation is in progress at places separated from the main waters of the gulf by small creeks.

Some of these inlets penetrate six or seven miles from the coast through a tract covered for miles in extent with shurbs. At low water, these plants are exposed to their roots ; but at high tides merely their upper branches are visible, so that the boats sail through a marine forest, the sails and yards frequently brushing against the boughs of the trees. The growth of these shrubs is so rapid, that the sailors have very often to force their boats through the upper branches, particularly at the various angles of the very tortuous creeks, when they wish to save a tack, and the wind is scant. The stems and branches of the trees are covered with Crustacea and Mollusca, whilst numerous water-fowl occupy the higher branches ; the whole presenting a most curious picture. That the land should gain on the sea, in these places also, is very natural, as during the monsoons, when the numerous small streams convey their muddy alluvium into the gulf, the roots and stems of the shrubs act as a filter, and the water passing slowly between them, a great portion of the earthy matter is precipitated ; a portion also adhering to the stems.

Effects of Floods.—Considerable damage is frequently done by the periodical floods, which, from the peculiar hilly structure of the country, sometimes rush down with a force, that carries all things before them.

In August 1834, the rains were very violent and long-continued, and did considerable damage. The river, which flows past Nurra, and through the flat, from six to eight miles broad, which extends from the town to the Runn, brought down so much alluvium, as to cover with a fine soil a surface of 150 pragas, or nearly 1000 acres of land. This tract had been sunk by the earthquake of 1819 so nearly to a level with the Runn, as to have remained unfit for cultivation. On the opposite side of the province, at a village called Kundagra, not far from Mandavee, 50 pragas or 300 acres of soil were entirely washed away, leaving a bare

sandy surface, similar to the bed of a river; and not far from the same spot, half a small village, with a quantity of land, was swept bodily into the sea; large trees being uprooted and carried down by the flood. At Pheraudee, 12 miles N. E. from Mandavee, at Mandavee, and many other places, great devastations are said to have been produced. A few similar inundations would alter the features of the country, consisting of such abrupt hills and loose surface-soil.

8. Volcanic and Trappean Rocks.

The district composed of volcanic and trappean rocks is one of the principal features in the geology of Cutch, not only from the space it occupies, but from the phænomena which it presents.

The igneous origin of trap being acknowledged, I shall always speak of it and lava under the comprehensive term of igneous rocks, as in composition they differ only in the proportions of hornblende, felspar, and augite, and as they all appear to have originated in the same cause, and to have equally disturbed or affected the neighbouring strata. But there appears to be a very marked distinction between those rocks which have been in fusion below the surface, and subsequently forced up, and those sedimentary formations, which have an altered appearance, and have been evidently subjected to violent heat since they were deposited in their present position. The latter rocks, however, bear a very small proportion to the former.

Evidence of the disturbing power of Igneous Agents.—It is impossible to desire clearer evidence of the disturbing power of igneous agents than is developed in Cutch. The shattered appearance of the country in some places, the upraised hills in others, with the igneous rock or moving agent, either directly under them, or immediately in front of the outcrop of their strata; the angles to which the beds have been raised varying from a gentle, unfractured slope to the most complete dislocations; the vast variety in the composition of the igneous matter, from the most loose and clay-like form to the most compact and perfect columnar basalt; the crater-like shape and construction of some of the hills, from which large lava or basaltic streams can be traced, prove the igneous origin of these rocks, and the vast effects which they have produced on the general appearance of the country. Moreover, it is not necessary that the igneous matter should be on every occasion apparent; as, where we find a large mass of basalt which has evidently come from below, lying on a plain, behind a hill presenting a bluff cliff towards the igneous rocks,

and the strata sloping sharply from them, the conclusion is obvious, that the hill must have been raised by the outburst of the volcanic matter; and it is equally just to infer, that, in its passage from below, it must have disturbed, more or less, the various beds through which it passed; and, therefore, that the form of many hills may be owing to a latent exercise of this power, even where no traces of the igneous matter are visible near the surface, or near the raised strata. That the greater number of these igneous rocks have been forced up, and are not portions of lava streams which have flowed from volcanos, is very evident, from the manner in which the superimposed strata are affected by them.

In a preceding part of the paper I have described a hill of quartz rock near Mhurr, and shown that its strata have been violently disturbed; and I have also inferred, from the nature of the rock, that its characters are due to grains of sand having been agglutinated by volcanic heat. In detailing the phænomena presented by the second formation, I have shown that its strata have been also subject to great dislocations.

In describing the upper secondary formation, I have stated, that I conceive the hills owe their outline, presenting to the north an abrupt escarpment resting on a slope, and to the south an inclined plane, to the agency of volcanic forces. In the Karee river, near Bhooj, these beds have been disturbed to an extent which defies representation. Near the village of Jarra, on the borders of the Runn, a bank affords a good example of the manner in which this upheaving power has acted. The laminated beds (upper secondary formation) being of a loose earthy character have yielded to the disturbing agent; whilst the overlying compact stone has broken short off, and presents a wall of rock, split by such perfectly vertical lines, that at first sight I thought the stone was columnar.

The range of Roha-ké-Koss, composed of beds of the fourth or upper secondary formation, is a good example of disturbing action. It is situated between the villages of Joorun and Lodye, on the borders of the Runn, and extends nearly east and west for eight miles, presenting, to the north, a perpendicular cliff of sandstone, which rests on a sloping talus of laminated sandstone and slate-clay, and dipping at a high angle to the southward. About three quarters of a mile from this main range, and parallel to it, is a ridge of smaller hills, consisting principally of basalt, intermixed, in some places, with the same sandstone as that of the main hill; and which, in the banks of the nullahs at its base, overlies, the laminated strata. The space between the two ridges is composed of large broken masses of sandstone, covered by a thick bed of gravel

evidently the detritus of the hills. In this instance, the strata of the Koss range dip towards the south ; and, at a short distance to the north of it, we find a mass of basaltic or igneous matter, which probably raised the hills in its passage up, and established itself at their foot. Large basaltic dykes, disturbing the strata through which they pass, are observable in many of the river banks in the immediate neighbourhood.

The beds of nummulitic limestone, on which Luckput stands, present, as before stated (p. 321), most decided marks of elevatory movements, consisting of a central platform of horizontal strata, with inclined beds on the flanks.

Another most striking example of the effects of igneous action in upraising hills, occurs in the nummulitic limestone, near the village of Pun-undrow ; and the phænomena are so strongly marked, that they deserve a detailed description.

On leaving the village of Korah, in the north-west department of the province, and proceeding westward, a range of hills is entered, of small altitude, but covering a considerable area. It is composed of a confused assemblage of basaltic cones in broken columns, or rather of a number of sugar-loaf-shaped masses piled one on the other. The surface of the hills is covered with fragments of a hard greenstone, the crystals of felspar being numerous. The perpendicular banks of the nullahs and ravines which intersect this range, present, in some places, entire sections of the columnar basalt ; whilst others consist of a friable, sandy clay, disposed in horizontal, thinly laminated strata of every shade of black, red, and yellow, to white ; and associated with it is a beautiful purple loam. The basalt sometimes overlies these beds, sometimes forms dykes in them ; and one side of the ravine frequently consists of this variegated loam, and the opposite of basaltic pillars. In many places the ground has an altered appearance ; the ironstone, of which large quantities are lying about, appearing partially fused, and the clays or variegated marls variously acted on, and always accompanied by dykes of basalt. These hills continue about eight miles from Korah to the village of Ukri, where they gradually decline into a plain, throwing off numerous ridges or forks. About three miles distant, a solitary hill, with a flat but uneven top, called Baboa, rises out of the plain. To this hill I wish to draw particular attention ; and the foregoing account of the basaltic range has been given as necessary to a proper understanding of it.

The first part of this plain is composed of thick beds of gravel, but further westward it consists of the nummulitic formation. Out of this soil rises the Baboa hill, composed of hard limestone, full of marine remains. One of the forks projecting from the basaltic range reaches to within

half a mile of the hill, the ground near it being strewed with small fragments of igneous rock.

The cause of the elevation of this hill is, in my opinion, distinctly visible in the banks of a river which passes by its western base. They are from 20 to 30 feet in height, and are composed of white calcareous marl, covered by a thin bed of gravel. Immediately opposite the hill, these beds are cut through by a dyke of very compact dark green basalt, forming, towards the river, a wall about eight feet high ; its base being hid by a talus of gravel. In several places on each side of this dyke, which is about 50 yards in breadth, independent masses of igneous rock break through the marl. They are principally of a blunt, conical form, capped with portions of the marl, and consist of spheroids of basalt, which desquamate in concentric layers, precisely resembling scales of iron. At a short distance up the river, or northward, this marl is covered by a stratified series, dipping at a high angle to the north, and consisting of a yellowish marl, with small imbedded fragments of lignite, covered by a bed of blue clay, containing also fragments of lignite and quantities of an olive-brown earth, in which small pieces of either amber or mineral resin are inclosed. Above this bed is a stratum of red sandstone ; and the whole is covered, at its lower extremity, by a thick bed of gravel. These inclined beds reach the level of the water about 400 yards from the basaltic dyke, beyond which the marl again appears in horizontal beds. Southward of the dyke, the change from the broken part to the undisturbed horizontal strata, is much more abrupt, occurring within a very short distance. On the top of the bank adjoining the south end of the dyke the stratified beds of blue clay, &c. are horizontal.

From the above description it appears, that the only place in which the basalt is exposed, is directly under the hill, no trace of it being discernible either above or below this spot ; also, that the most compact and extensive mass of basalt is exactly under the highest part of the hill ; and that detached masses of igneous rock present themselves, with large portions of the marl adhering to them. A series of stratified beds is also noticed rising from the north towards the hill, meeting the surface at its foot, and is again found in a horizontal position just south of the hill. All these facts surely prove, that the hill must have been elevated by an outburst of igneous matter, which was probably a branch from the basaltic hills to the eastward ; one of its forks reaching within half a mile of the spot.

Quantities, of what I believe to be frothy or foam lava, being a brownish black substance, very vesicular or spongiform, extremely light, and

somewhat similar to a very porous cinder, are found adhering to the marl, and in the rubble of the bank.

Large blocks of the shelly limestone, composing the summit of the hill, are scattered about its sides and base; and some of them, my guide informed me, fell during the earthquake of 1819; and the abrupt and steep sides are, no doubt, due to the action of water. Numerous fossils are found lying about, characteristic of the nummulitic limestone.

I have minutely described this hill, in the hopes of impressing others with the same belief as myself, of the cause of its elevation.

Near the village of Nambye, in the Charwar range, a basaltic dyke traverses beds of thinly laminated slate-clay and layers of limestone slate. In the immediate vicinity of the dyke the strata dip in all directions, and form even anticlinal lines. The basalt is very hard, compact, and of a dark blue colour, and presents irregular masses, without the slightest approach to a columnar structure.

Distinct Periods of Volcanic Eruption.—That the volcanic eruptions have occurred at many distinct periods, is also evident, from the different formations with which the igneous rocks are associated, and from the variations in their characters. Thus, in the same section, the lower part frequently consists of large, rolled, or water-worn masses, whilst the upper portion is columnar: in other places the basalt alternates with a calcareous grit or coarse limestone, having a tabular structure, but always distinctly stratified, and very brittle, so as to present perpendicular banks. This limestone is generally associated with basalt, where the latter is raised into hills; and from the fact of *angular* pieces of basalt or igneous matter being imbedded in it, would incline one to believe that, in such cases, it must be contemporaneous, though it often regularly alternates with it. In other places the basalt is interstratified with a pure crystalline limestone or travertin.

The principal mass of igneous rocks lies towards the southern department of the province, and forms a group of hills called the Doura range; the intervening spaces and the ground at their southern base generally assuming a porphyritic structure. The northern parts of the range have, for the greater part, a flat, smooth outline; but in the interior of the group are many clusters of small, conical hills, arranged round a circular space, inclosing a kind of hollow. The sides of these cones are very steep, and invariably present innumerable horizontal lines, forming rings resembling narrow paths. The surface being covered with basalt, in very small pieces, is totally devoid of vegetation, and has precisely the

appearance of a newly-laid macadamised road. Their interior, however, has a much more solid construction, as is well seen in numerous deep clefts and ravines with which the hills are in all directions intersected.

One of these ravines, near the village of Doonee, is 50 or 60 yards broad, and nearly 100 feet deep; and its perpendicular sides are composed of compact columnar basalt of a greenish grey colour; the columns being perfect polygons, and of a very large size. This rent must have been formed by some convulsion, as it reaches nearly to the summit of the hill; and the only water that could ever have flowed down it being that which falls on its sides and bed, and must be very little.

Alternations of Basalt with Strata of the Upper Secondary Formation.—Near Nurra, on the borders of the Runn, a hill called Jogé-ki-bit, basalt alternates with slate-clay, limestone slate, slaty limestone, and a laminated loam. The strata dip from 40° to 50° to the north, which being at a higher angle than that at which the hill itself rises, it causes them to crop out; the surface being also broken into several distinct ridges. The igneous rock alternates three times. In one instance it underlies a stratum of hard slate-clay; in another it occurs between a coarse, soft sandstone, and slate-clay, and sandstone slate; and it also forms the conical summit of the hill, which is not more than ten feet in diameter. The basalt desquamates in flakes, but has a centre of compact rock. The same inclination of the beds is continued through the hill.

Alternations of the Calcareous Grit with Basalt.—At the village of Doonee, above mentioned, the banks of the river present a perfectly perpendicular wall, from 15 to 20 feet high, and are composed of the calcareous grit, or coarse limestone alternating with basalt, in the following order: first, grit; then a horizontal bed of rounded pieces of basalt; and next, another stratum of the grit, 15 feet in thickness; the whole being covered by the basalt forming the hills.

Another good example of this alternation is near the village of Keroee, at the eastern limit of the formation. The banks of a river are here composed, in some places, of the basalt forming the Doura range; and in others, entirely of the limestone grit, which in one place overlies the basalt, but forced up into anticlinal lines, as if the igneous rock had been protruded from below; the broken state of the strata showing that it was not originally deposited in this position. The bed of the river at this place is entirely composed of basaltic columns; their horizontal sections forming a regular pavement; and large masses of the columns,

occupying from 200 to 300 square yards, and being about eight feet in height, remain every here and there, similar to a field of corn partially reaped. The columns are very regular, generally four-sided, with smooth, even surfaces, and are composed of a hard, compact, dark blue basalt.

Another instance of the junction of the limestone grit with the basalt is near the village of Choolree, a little to the westward of Kaira. The basaltic range is completely divided by a narrow ravine, in which the two rocks appear in contact, the limestone being broken in all directions. One side of the ravine presents a perpendicular cliff, of nearly 80 feet in height, of irregular columnar basalt, overlying a bed of rounded masses of the same, though the opposite bank is composed of the limestone grit. Advancing through the Pass, the basalt terminates abruptly, and is succeeded by the limestone grit, which forms both sides of the ravine. Further on, the basalt again appears in the form of a dyke; beyond which is the grit, once more succeeded by a dyke of basalt, forming, at this extremity of the Pass, both banks. Where the dykes of basalt occur the limestone lies in immense masses, evidently broken off at the time of the projection of the upper bed of igneous rock; being itself of subsequent formation to the lower basaltic bed of rolled masses. This is very distinctly shown at one part of the Pass; and it should be mentioned, that the bed of the ravine consists throughout of irregular or broken basalt.

The intervening spaces and the ground at the base of these hills are composed, for the most part, of a red clay much resembling brick, a variety of it being amygdaloidal, of a darker colour, extremely hard and tough, and containing quantities of calcareous spar, chalcedony, rock crystal, &c.

In some places it forms low ranges of hills of a hard rock, of a dingy red colour, thickly interspersed with cylindrical kernels of zeolite, with a light green coating, some of them dividing into two parts. Other specimens contain numerous crystals of felspar; and, in many instances, all the mineral substances have disappeared, leaving a vesicular mass. Occasionally, thin beds or layers of calcareous spar, of a leek-green colour, are met with, also of rock crystal and chalcedony in all its varieties. The surface of the plains is covered with fragments of these minerals, derived from the disintegration of the amygdaloids, which are rapidly affected by exposure to air and water. Some of the sides of the hills are covered with heaps of rock crystal, as if cart-loads had been purposely thrown down.

Alternation of Basalt with Travertin.—A very good example of successive eruptions of basalt occurs near the small village of Wurrowsow, on the south-western flanks of the Charwar range. This point must at one period have been a lake, it being now a dead flat, about 4½ miles in diameter, and surrounded by low but steep hills, whose surfaces are covered with small fragments of basalt; its general level is about 20 feet above the ground to the east of it. The soil consists of alluvial matter and fine gravel, totally different from the sandy plain by which it is bounded; but its most interesting feature is the basalt at the eastern outlet or break in the low surrounding hills. This mass of trap consists of perfectly polygonal columns about 25 feet in height, but broken into lengths, forming a series of regular steps, cut into a horseshoe shape by a small stream, which discharges itself during the rainy season. The hills that flank it on each side are composed of a base of coarse sandstone capped by an earthy basalt, a dyke of which, 8 or 9 inches wide, has, in one spot, penetrated the subjacent sandstone.

The friable basalt forms the base of the fall. Above the columns the bed of the small stream consists of a loose, calcareous calc-tuff.

This section presents several interesting facts; as, from the alternation of basalt with the limestone or travertin, it is evident, that a considerable time must have elapsed between the igneous eruptions. The variety in the texture of the limestone or travertin may be accounted for by supposing, that the waters under which it was deposited were sometimes perturbed, or rendered muddy by a flood; but at other seasons clear, when a pure calcareous precipitate would take place. The basalt forming the columns is very hard, compact, of a dark blue colour, and smooth surface; and it may be traced to some small hills northward of the spot.

Near this place the surface has been affected in a manner worthy of observation. Every here and there, a small spot, varying in size from 3 to 20 yards in diameter, has been raised into a convex form; the pavement, that covers it, consisting of tabular plates of slaty sandstone, broken into small masses; and the fractured lines generally radiating, though in an irregular manner, from a centre. In some places the tops of these little globular elevations have been removed, leaving a regular circle of stones, whose bounding lines are disposed like the stones of an arch. In other instances they assume a more conical shape, resembling small hillocks, from the upper part of which the outer coating or tabular masses have generally fallen away. When they are of a larger character, the whole presents a heap of broken masses of rock.

Denodur Hill, an extinct Volcano.—Of the detached hills, the elevation of which I conceive to be due to volcanic influence, the principal is that called Denodur, and is situated near the shores of the Runn. It is the largest and highest hill in the country, and is evidently the remains of an extinct volcano, an irregular crater being still visible. In the north side is a large gap, reaching nearly to the foot of the hill, but partially blocked up by a lower ridge, or a kind of traverse. Its western flanks are composed of a series of ridges of laminated clay and loam, interspersed with flat, angular fragments of slaty sandstone and slate-clay. The surface of some of these ridges is smooth, consisting either of thin slabs of slate-clay, or of thicker slabs of a very compact, crystalline, and slightly calcareous stone, the same as that which overlies the laminated series, and forms the walls on the Runn, &c. Near the base of the hill and for more than two-thirds up its side the construction alters, being composed partly of a loose sandstone, and partly of the calcareous grit, containing imbedded, angular fragments of basalt; the uppermost part is a perpendicular wall of basalt, which, apparently, continues all round the top. A stream of very compact basalt runs past its north-western flank, and in other places. Numerous small conical hills, composed of horizontal layers of limestone grit, or of basalt, are scattered over its sides, and its base is covered with a thick mould, formed of decayed vegetables, with earthy matter. Nowhere did I find any traces of recent disturbance, although the people of the neighbourhood, particularly the Jogees, or religious devotees, who inhabit a temple on its northern flank, asserted that fire issued from it during the earthquake of 1819. If it did, there would, of course, be some signs of it remaining; but I was unable to penetrate into the interior of the hill, owing to the dense Bauble Jungle, or crooked thorn tree with which it is covered.

Not far from this place, and adjoining the village of Nuckutrana, is a hill of some size, called Ungia-soorud, the elevation of which has also been effected by volcanic agency. The flanks and base are composed of a very loose, friable, calcareous sandstone and grit, apparently stratified, but inclined at all angles; and the remainder consists of very compact basalt. The hill is divided into two parts by a narrow, tortuous cleft, the sides of which are nearly perpendicular, and composed of irregularly triangular prisms of basalt. The cleft is not more than four feet wide at the bottom, though it is somewhat broader at the top; and as it passes completely through the hill, we must suppose the whole to be similarly composed.

All the other numerous isolated hills scattered over this part of the province, including that called the Nunnaw, next to Denodur, appear to be similarly constructed.

The hill called Lecka, deserves particular notice. It forms one of a group of hills on the borders of the Runn, at the north-western extremity of the province, and is composed of two portions; one consisting of stratified beds of sandstone; and the other wholly of basalt, in irregular, triangular columns. The beds of sandstone are horizontally disposed, and of various colours and textures; the lowest stratum being a coarse, brown, quartzose grit. The igneous rocks crop out in various places near this spot, forming a cluster of small hills between it and the Jooria range; the intervening spaces being broken in the most confused manner.

Recent Outbursts.—Having given as many examples of the elevatory effects of volcanic action as my space will admit, I shall conclude my account of their phænomena with a description of some igneous outbursts of, apparently, a very recent epoch. The principal one occurs at the village of Wagé-ké-Pudda. The spot which has been acted on is a rather high table-land, composed of the nummulitic marl, and is flanked by low, irregular hills of ironstone and gravel, called by the natives Kara Rurraw. The first view of it, is very striking. Conceive a space of about two square miles, blown out into a flat basin, the sides being broken into fissures, with craters, ravines, and hollows; and the interior, or bed of the basin, interspersed with hillocks and cones of every variety of colour, black, red, yellow, and white, and with patches of cinders, similar to the refuse of a furnace; the whole looking as fresh as if the igneous agents were still in operation.

The surface of the table-land immediately surrounding the blown-out space, is covered with a burnt ironstone, divided into irregular cells, similar to Septaria; below which are steep banks, 40 to 50 feet high, consisting of comminuted particles of clay, sand, gravel, scoriæ, and small angular pieces of basalt; the whole being loose, and having a dry and brittle feel.

Within the centre are several small craters, or circular spaces, surrounded by walls of basalt. None of them are perfect circles, being broken through by watercourses; but one has about two thirds of its circumference complete, the sides of which, about forty feet high, are in the upper part quite perpendicular, and consist of very compact basalt, of a columnar structure; while the lower ten feet present a talus, composed of volcanic

sand, and scoriæ in very thin laminæ. Below the columnar basalt is a bed of a friable variety, three feet in thickness. In some parts the columns are capped with a thin band of ironstone. The interior of this crater is about 80 yards in diameter, and consists of volcanic sand, with imbedded angular fragments of basalt. The most perfect of these craters, or circular spaces, are generally hid from view, being approachable only by the narrow ravine forming the outlet of the watercourse which cuts through them. The basalt varies greatly in texture and general appearance : in some places it is columnar, exceedingly hard and compact, in others it contains imbedded crystals of felspar, and it occasionally presents the structure and texture of an amygdaloidal clay. Some varieties also consist of concentric layers of a kind of brittle, clayey substance, inclosing a nucleus of hard rock ; the whole being imbedded in a mass of clay, which looks as if a number of small roots were entwined about it. All the varieties are frequently found in the same bank or hillock.

Several other small basins have been blown out in the surrounding table-land, forming inverted cones, about 15 or 20 feet in depth ; and are composed of the same materials as those just described. Many of them consist entirely of small, brittle particles, of a pale yellow colour, evidently sulphuric. The clay has, in various places, been burnt into a perfect brick ; and the marls, or sandy clays, are frequently of a beautiful bright purple. Quantities of talc, or mica, lie scattered about, twisted and contorted into a variety of shapes ; and some of the iron ore which covers the surface, appears to have been partially fused, consisting of a spongy, vesicular mass. The whole has the appearance of having been for some time subjected to considerable heat, and then suddenly blown up. The cones and banks of loose volcanic scoriæ must be yearly washing away ; and it is difficult to conceive, that the walls of solid basalt forming the sides of the craters, can belong to a similar period, having all the appearance and texture of very old basalt ; but it is possible that a recent eruption may have taken place in the site of one of a more ancient date, thus presenting a mixture of old and recent volcanic products. If it is true, that basalt owes its columnar structure to its cooling slowly under a great pressure, it is impossible that these masses of columnar basalt and the loose cones of scoriæ can be contemporaneous.

In the nummulitic marl forming the banks of a river which flows past this patch of blown-up ground, is a stratum of earth containing small nodules or rounded masses, of a pale yellow colour, translucent and brittle, and which burn with a bright flame, giving out a strong aromatic odour. It is contained in a dry, olive-brown earth, so light as to float in water.

Numerous *Echinodermata*, and other fossils, are found on the table-land, and some of the fields are thickly strewed with casts of a Turbinella of a very large size, the external shell being always wanting. On breaking them, small fragments of igneous matter are found in their interior.

In the table-land just south of the outburst, is a large fissure, about a quarter of a mile in length, 40 yards broad, and 40 or 50 feet deep. One extremity communicates with the river, and the other is rounded, or formed into a basin shape. The sides are perfectly perpendicular ; and it is clearly an opening in the ground, there not being the slightest indication of anything of the kind, until directly at its brink. I was informed by a native of the village, (the only present inhabitant,) that smoke issued from the outburst about twenty-two years since ; but little dependence can be placed on the statements of these people.

Another similar, but smaller, outburst occurs about three miles south of Mhurr, near the spot in which, in my account of the tertiary deposits, I mentioned that a large basaltic dyke crosses the river. The space here blown out, does not exceed 100 yards in diameter, and 15 feet deep, consisting of similar cones of volcanic scoriæ, and comminuted particles, as above described ; but there is no trace of any basalt nearer than the dyke in the river.

From what I have now detailed, it appears, that igneous action has affected all the formations of which the province is composed ; and it will also appear, by the following details, that the Grand Runn, the most remarkable feature of the country, owes its peculiar characters to volcanic action.

The Grand Runn.

With a short account of this large and singular tract, I shall conclude the paper. It has been described by Captain Burnes, in a memoir in the library of the Royal Asiatic Society; and referred to, at considerable length, by Mr. Lyell, in his "Principles of Geology."*

This tract, containing an area of upwards of 7000 square miles, exclusive of the space occupied by the Bunnee, and the islands of Puchum, Khureer, &c., is, perhaps, unparalleled in any known part of the globe, as it may be said to be placed on a level between land and water. It is dry during the greater part of the year, when its surface consists of a sandy flat, totally devoid of vegetation ; but, perhaps, on account of its

* 5th Edit., vol. ii. p. 183 *et seq.*

saline nature, always sufficiently moist to prevent its particles being drifted. During the prevalence of the south-west winds, however, so much water is blown up its eastern inlet by the Gulf of Cutch, and, at its western extremity, by the eastern branch of the Indus, as to cover its whole surface; augmented by the freshes, which, at the same time, come down the Loonee and Bunass rivers, and the numerous small streams which intersect the northern coast of Cutch. At those seasons, the Runn has all the appearance of a sea, and is passable only on camels, and, in some seasons, with difficulty. It has been described as the dried-up bed of a sea; but it is not easy to account for its drying up, unless we suppose a general depression of the ocean. We must, therefore, look to other causes.

In several parts of the world, particularly in the Baltic, there are undeniable proofs of a gradual rising of the land; and, in time, parts of that sea might be converted into a tract similar to that of the Runn.* It does not become me to inquire whether this gradual elevation is due to a series of so minute elevatory movements as to be unnoticeable, except from the effects which subsequent measurement proves them to have produced, or from a gradual expansion by volcanic heat. But in Cutch we have evidence of movements within a very late date, and every reason to believe that similar ones have occurred at various periods. The earthquake of 1819 is known to have produced a remarkable change on the western extremity of the Runn, by throwing up a mound 50 miles in length, 16 in breadth, and 18 feet high; and by depressing an adjoining tract, so as to convert it, from a cultivated district, into a large salt lagoon. As the changes in level, thus effected, have, however, been detailed in other papers, I shall merely observe, that when I was at Luckput in January, 1834, very little if any change had occurred since Capt. Burnes' visit, in 1828; except that the Sindians had repaired all the bunds across the river, and thus, by preventing further supplies of fresh water, the lagoon had assumed much the same appearance as previous to the freshes of 1828.

I was also informed by a boatman, who constantly plied up and down from Ullah-Bund to the sea, that between Sindoo and Sindree, there is a bank, six miles broad, covered by only one foot of water; and as there is no channel through it, the boatmen are obliged to get out and haul the boats across the bank, after which they follow the windings of the channel to Ullah-Bund. It would therefore appear that this portion

* See Mr. Lyell's Memoir, on the proofs of gradual rising of the land in Sweden. Phil. Trans. 1835, p. 1 *et seq.*

could not have been so much sunk as that around Sindree, and between it and Luckput.

I was also assured that pieces of iron and ship-nails have been thrown up from fissures in the Runn; and Capt. McMurdo* mentions a boat which had been buried under 15 feet of alluvium, having become exposed in a mud-bank, near the village of Wuwania, on the Kattywar side of the Runn, or where it joins the Gulf of Cutch.

The number of places still pointed out as Bunders, or quays, together with the large stones formerly used as anchors, one of which still lies on a small elevation on the Runn, not far from the Puchum Island, and the confident assertion of all the inhabitants on its coast, tend to confirm the opinion that the district must once have been covered by a navigable body of water.

Some parts of the shores have precisely the appearance of having been recently deserted by the sea. This is particularly the case near the village of Charee, which is separated from the Runn by a low range of hills. To the northward of this range is an inlet, about one mile and a half in breadth, and it looks precisely like a small creek or bay from which the tide has just ebbed. Its surface is composed of smooth, whitish clay, with numerous scattered gravel banks, the ends of which have been worn round, and the sides present perpendicular or overhanging banks. Several masses of crystalline sandstone also rise suddenly out of the bed; and some of them consist of immense fragments, which look as if they had been piled one on the other, and have a strange effect from a short distance. Beyond the inlet is another range of hills of the same description, but it is more broken and confused than any other in the country. In some places, the upper stratum of hard rock has been thrown into a position like the roof of a house; in others, it precisely resembles a ruined fort with towers on a hill; but the greater part of the stratum is a confused assemblage of huge fragments of rock. Northward of this range, and separated from it by a narrow belt of the Runn, is a steep conical hill, called Keera, 600 or 700 feet in height, consisting partly of the same materials as the others, and partly of basalt; and it appears to have been formed in a similar manner to the hill called Ungursoorud, before described, and others of that class. It is also more than probable, that the peculiar, fractured appearance of all the ranges is due to the same cause acting at the same period.

Supposing the bed of the Runn to have been raised by a series

* Extract from Captain McMurdo's MS. memoir on Kattywar, in Captain Burnes' Travels in Bokhara, vol. iii. p. 329, *note.*

of violent movements, such as must have upheaved the Keera, and its surface to have been broken, and covered with fragments of rock, its present level outline may be ascribed to subsequent operations. The Runn is bounded to the north, as already stated, by the Thur or Little Desert, a district composed entirely of sand. The Loonee and Bunass rivers also flow through a sandy soil, as do many other streams which enter from the Cutch side. Now, during the periodical floods, vast quantities of sandy alluvium must have been brought down by these rivers, deposited at their mouths, and washed thence and spread over the surface of the Runn by the sea-water annually blown up at its eastern and western extremities. This operation, repeated yearly, would fill up all inequalities, and produce in time a level surface. It is probable, however, that the present state of the district may also be, in some measure, owing to a gradual rising of its bed, as it is only to such operations that some of its shores, as those of the inlet above mentioned, can be ascribed.

There are also many facts to prove, that this tract has been elevated at very different periods. The high hills bordering its southern shore are, as before stated, composed principally of the laminated series, and their surfaces are covered with Ammonites, Nautilites, Belemnites, and other fossils of that geological period ; whereas along its immediate line of shore, there are generally low ridges, composed of rocks full of marine remains of a totally different character, many of them belonging to existing species. Numerous small rocky islets, consisting of shells agglutinated into a solid mass, occur in various parts of the Runn, and are barely raised above its present level. They are probably merely the higher portions of large tracts, the lower parts of which are covered by sediment.

Natural Walls on the Runn how formed.—Still more striking instances of the effects of upheavement, since the Runn assumed its present characters, are exhibited in the detached, elevated masses of rock which I have called the *Natural Walls* on the Runn.

They consist of disconnected portions of rock rising abruptly from the surface of the Runn, and presenting a smooth, vertical wall, occasionally upwards of thirty feet in height, and in one instance upwards of two miles in length. Some of them resemble domed or vaulted buildings, the reversed side consisting of a talus of broken fragments of rock and soil. In one place these walls form a semicircle about 500 yards in diameter, both walls sloping outwards. That the walls have been uplifted into their present form is quite evident, first, from the stones being all on end, that is, with the grain in the direction of their present position,

and peeling off in scales down the face of the wall; and secondly, from my having met with the same phenomena on a smaller scale, in other parts of the country, where the slabs of rock are at all angles, and even, as those before mentioned, turned over. It should be noticed, also, that the borders of the Runn, near these walls, are composed of friable beds of the laminated series, covered with thick tabular masses of hard sandstone, precisely similar to those forming the walls.

Had they been uplifted during the permanent prevalence of the waters, the sloping talus of earth and fragments of rock, with which they are all backed, must have been washed away. It should be stated, that these examples are situated on ground now almost recovered from a state of Runn; some parts having been sufficiently augmented by means of the sandy alluvium, washed down from the neighbouring hills to support vegetation; whereas the isolated rocks, several of which rise out of that part of the Runn, and are still subjected to inundation, have no detritus or talus, but present smooth walls of perpendicular rocks. I could never perceive any water-marks on them, nor any remains of marine testacea, which might occur, had the sea ever washed the present level of their foot. It is probable that their original base lines have become obliterated by the sediment which must have accumulated round them in course of time, and which forms the existing surface.

A very good example of a similar wall occurs in the centre of the province, near the village of Rampoora; it is a ridge of coarse sandstone about 300 yards in length, and from 10 to 15 feet in height, the stones being evidently placed edgeways, and in so regular a manner as to resemble precisely an artificial wall. It rises from a base of the same sandstone, and on one side it is nearly flat, but broken into masses, while on the other side are heaps of stone, broken and confused, and the interstices are filled with sand and small trees. At the extremity of the wall the stones slope up like the end of a roof. In the immediate vicinity of this wall is a small range of basaltic hills, striking however at right angles to the direction of the sandstone ridge.

Some of the rivers which flow towards the Runn from the Cutch side are lost in the sand at their mouths; though at a short distance up the bed of the river, the stream runs freely. It would thus appear, that at these spots, the bed of the Runn has been increased, by the sediment, probably, brought down by the stream; but so loose is the soil, that the water soaks into it and even flows under it, instead of wearing channels. This phenomenon is observable in the sandy beds of many of the rivers in the province. The stream may be noticed running with some rapidity and of a sudden to cease, the bottom of the river presenting a smooth sandy surface; but a mile lower down the water again issues and con-

tinues its course; the intervening parts being sometimes quite hard and dry; in others forming very dangerous quicksands.

The natives have various traditions that the drying up of this sea was sudden, and that boats were tossed on the land and wrecked; they pretend also to assign a date to this event, but their accounts differ so materially and are so vague, that not the slightest reliance can be placed upon them, except to the general fact.

It is evident that the Runn could not have been drained by the bursting of its boundaries, at least since it was deep enough to be navigable; because its present surface, notwithstanding the sediment which yearly accumulates on it, is even now so little raised above the sea's level as to be flooded by the mere effects of the wind; but the most probable supposition is, not that it was ever a detached inland sea or lake, but that it communicated with the ocean by its present outlets, and that its bed has been raised, partly perhaps by a gradual movement, and partly by violent upheavements during earthquakes. Even such marked changes of level as the raising of Ullah-Bund, and the sinking of the ground near the large town of Luckput, would have passed unrecorded but for the accidental circumstance of the district having been visited by a British officer. Other portions of this vast area, the greater part of which is never traversed by man, may have been similarly affected at that time, and yet the changes remain unkown.

Successive Marine and Freshwater Beds.—The submerged tract near Luckput, or Lake of Sindree, may, I think, illustrate the manner in which successive marine and freshwater deposits may be produced. This tract was at one period a richly cultivated district, periodically flooded by a branch of a great river, and produced large quantities of rice. In this state numerous land testacea no doubt occupied it, and were mixed with the remains of fluviatile species brought down by the floods. The bones of animals used in agriculture, and those of various domestic species, also the remains of broken pottery, perhaps coins, and other proofs of civilized life, might likewise have been imbedded. Suddenly, owing to the damming up of the river by the Sindians, the supply of fresh water ceased, and the tract was no longer cultivated or inhabited. Some time after this an earthquake occurred, uplifting one part and depressing below the level of the ocean another, which was immediately converted into a salt lake. A perfectly new description of deposit and organic remains must then have been accumulated, consisting wholly of marine animals, principally such as inhabit shallows and tideways. Again, owing to the sudden melting of the snow on far distant mountains (the Himalayahs) the waters of the river came down with such force as to burst all the bunds built across it, as well as that

thrown up by the earthquake, and covered the tract with fresh water, or perhaps with fresh at its upper or northern extremity, and brackish at its southern near the sea. Supposing this state of things to have remained for some time, the river continuing to pour its water into this lagoon, another change would take place in the description of the sedimentary deposit. Once more the bunds were erected across the river, the supply of fresh water ceased, and as that on the lagoon evaporated, the sea again flowed in and converted it into a salt lake, which is its present state. All the above changes are known to have occurred; and it is easy to suppose that if the shallow part at Sindoo were slightly raised above its present level, thus shutting out the sea, the part around the Fort of Sindree would be converted once more into dry land. If, therefore, at any future period, the river should again cut a channel, the banks might present various, regular beds alternately enclosing marine and freshwater exuviæ, the latter being also associated with land productions.

The ruins of one of the towers of the Fort of Sindree remained, when I visited Luckput in 1834, and in all probability now stand as a monument of the changes, which are daily taking place on the earth's surface.

Conclusion.—In concluding this paper, I have only to observe, that I have throughout endeavoured to describe facts as they appeared to me at the time I examined them, without regard to any particular theory; and if I have failed in making my descriptions intelligible, I have only to plead the difficulty of having had a great deal to describe in a limited space. As the country to which this memoir relates is, however, unfortunately from its geographical position, beyond the reach of general observers, I am induced to hope, that this sketch, however imperfect, may be found to possess some interest.

For the arranged list of fossil shells, given in the Appendix, as well as for all my information on that subject, I am entirely indebted to Mr. James De Carl Sowerby, who had my specimens (now in the cabinets of the Geological Society) for some time in his possession for examination.

Note.—In conformity with our practice of extracting from scarce or expensive works such articles on matters of Science connected with this country, as appear in European Periodicals, we have taken from the Transactions of the Geological Society of London the foregoing articles. We wish we could give copies of all the figures of fossils which accompany the original text, forming a most valuable addition to the palæontology of India, but their number precludes us from so doing—the difficulties and expence attending the execution of so great a number of lithographs being greater than the resources of this Journal could meet.—Ed. Madras Journal.

APPENDIX.

SYSTEMATIC LIST OF ORGANIC REMAINS, THE PLANTS DETERMINED BY MR. JOHN MORRIS, AND THE REMAINDER BY MR. JAMES DE CARL SOWERBY, A. L. S.

The fossils considered as belonging to previously described species, are distinguished by a reference to the work in which they were first noticed; the new species are described in the explanations at the end.

Class, Genus, and Species.	Formation.	Locality.	Remarks by Capt. Grant.
Plantæ.			
Ptilophyllum acutifolium	Sandstone, Clay with Coal.	South of the Charwar range.	
——— *Cutchense*			
Lycopodites affinis			
Fucoides (*Codites?*) *dichotomus.*			
Stems of Equisetites or a Monocotyledonous Plant			
Polyparia.			
Lycophris Ephippium (p. 321 *Orbitolites*)	Nummulitic group.	Baboa Hill and Wagé-ké-pudda.	Very abundant.
——— *dispansus*	Ibid		
Radiaria.			
Crinoidal stems	Upper Secondary.	Charee	Found on hills near Charee with Ammonites and other fossils.
Echinus dubius	Nummulitic group.	Baboa Hill, Wagé-ké-pudda.	
Galerites pulvinatus	Ibid	Baboa Hill	
Clypeaster affinis? Goldfuss, XLII. 6.	Ibid	Ibid. and near Joongrea.	
——— *varians*	Ibid	Ibid. and Wagé-ké-pudda.	

—— *depressus*	Tertiary	Soomrow	Found in great numbers, and similar in colour and form, to recent specimens, but flatter.
—— *oblongus*, Lamk.	Ibid	Between Joongrea and Kotra.	
Spatangus obliquatus	Nummulitic group.	Baboa Hill	Very numerous.
S. Buckl.? Goldf., XLVII. 6.			
—— *acuminatus?* Goldf., XLIV. 2.	Ibid	Ibid.	
—— *elongatus*	Ibid	Ibid.	
ANNULATA.			
Serpula? recta	Tertiary	Near Kotra.	Bodies of similar form occur in vast quantities on isolated banks in the river near Kotra.
Siliquaria Grantii	Tertiary	Borders of the Runn.	
CIRRIPEDA.			
Balanus sublævis	Ibid.	Soomrow.	
CONCHIFERA.			
Pholadomya? inornata	Upper Secondary	near Charee	Found on some hills bordering the Runn, which have been much disturbed by volcanic action.
—— *granosa*	Ibid	Ibid	
—— *angulata*	Ibid	Ibid	
Amphidesma? ovale	Ibid.	Ibid.	
—— ? *hians*	Ibid	Ibid.	
Corbula lyrata	Ibid	Ibid.	
—— *trigonalis*	Tertiary	Borders of the Runn.	
—— *rugosa*	Ibid	Ibid.	
Tellina exarata	Ibid	Soomrow.	
Astarte unilateralis	Upper Secondary	Charee.	
—— *pisiformis*	Ibid	Ibid.	
Venus granosa	Tertiary	Soomrow.	
—— *cancellata*	Ibid	Ibid., Kotra.	
—— *nonscripta*	Ibid	Soomrow.	
Pullastra? virgata	Ibid	Ibid.	
Cardita intermedia? Brocchi, XII. 15.	Ibid	Ibid.	

Class, Genus, and Species.	Formation.	Locality.	Remarks.
Trigonia costata, var. M. C., LXXXV.	Upper Secondary	Charee	Found in the same hills with the Pholadomyæ.
—— *pullus*	Upper Secondary	Charee	Found in the same bed as *Trigonia costata*.
Cardium intermedium	Nummulitic group.	Baboa Hill.	
—— *ambiguum*	Ibid.	Ibid.	
—— *triforme*	Tertiary	Soomrow.	
Cucullæa virgata	Upper Secondary	Hubbye Hills	A pass in the hills between Hubbye and Joorun is paved with these shells imbedded in a hard rock.
Arca hybrida	Nummulitic group.	Baboa Hill.	
—— *radiata*	Tertiary	Soomrow.	
—— *tortuosa ?* Linn.	Ibid.	Ibid.	
Pectunculus pecten	Nummulitic group.	Baboa Hill.	
Nucula tenuistrata	Upper Secondary	Hubbye Hills	In the same masses with *Cuc. virg.*
—— *? cuneiformis*	Ibid.	Charee	These shells form stony banks which project slightly above the bed of the Runn; also solid rocks in the Hubbye Pass.
—— *Baboensis*	Nummulitic group.	Baboa Hill.	
Pecten partitus	Upper Secondary	Hubbye Hills.	
—— *lævicostatus*	Nummulitic group.		
—— *Soomrowensis*	Tertiary	Soomrow.	
—— *articulatus*	Ibid.	Banks of the Runn.	
Plicatula pectinoides	Upper Secondary	near Charee.	
——M. C., CCCCIX.	Ibid.	Katrore Hill.	
Exogyra conica M. C., XXVI., DCV.	Ibid.	Ibid.	
Gryphæa globosa ? M. C., CCCXCII.	Tertiary	Kotra.	
Ostrea Marshii M. C., XLVIII	Upper Secondary	Katrore Hill, Charwar range.	Found in a bank in the hill.
—— *carinata ?*	Nummulitic group.	Charee.	

M. C., CCCLXV.			
—— *callifera ?* Lamk.	Ibid	Wagé-ké-pudda	Isolated banks in the broad river-bed near Kotra are completely covered with these oysters.
—— *orbicularis.*	Ibid	Luckput.	Masses, 15 to 20 feet thick, composed of this shell are scattered in the bed of the river.
—— *angulata*	Tertiary	Kotra.	
—— *Flabellulum* M. C., CCLIII.	Ibid	Cheeosir	The banks of a river near Cheosir are composed of a grit full of these fossils, and of a Cardium. They are generally distributed through the tertiary district.
—— *tubifera*	Ibid		
—— *lingua*	Ibid	near Joonagrea and Kotra.	
Terebratula intermedia, var. M. C., XV. 8.	Upper Secondary	Charee.	
—— —— *biplicata, var* M. C., XC. & CCCCXXXVII.	Ibid	Jooria Hill.	
—— —— *sella, var.* M. C., CCCCXXXVII. 1.	Ibid	Pass of the Hubbye Hills.	
—— —— *concinna ?* M. C., LXXXIII. 6.	Ibid	Jooria Hill.	
—— *nobilis*	Ibid	near Charee	Very numerous.
—— *dimidiata ?* M. C., CCLXXVII. 5	Ibid	Ibid, Jooria Hill	One specimen was found in gold-coloured oolite, in the highest part of the Jooria Hill on the borders of the Runn.
—— *major*	Ibid	Charee.	
MOLLUSCA.			
Bulla lignaria, Linn	Tertiary	Soomrow.	From the lower part of the hills. The shells found in this position differ from those in the highest part of the same hills, and appear to have been deposited in the shores of the Runn since those hills were raised.
Neretina grandis	Nummulitic group.	Wagé-ké-pudda.	
Natica obscura	Tertiary	Soomrow.	
—— *callosa*	Ibid	Ibid.	
Globulus obtusus	Nummulitic group.	Baboa Hill.	
—— *? anguliferus*	Tertiary	Borders of the Runn.	

Class, Genus, and Species.	Formation.	Locality.	Remarks.
Solarium affine	Ibid	Soomrow	Very numerous.
Trochus cognatus	Ibid	Ibid	
Turritella angulata	Ibid	Ibid	Very numerous.
——— *assimilis*	Ibid	Ibid	
Terebra reticulata	Ibid	Ibid.	
Cerithium rude	Ibid	Ibid	Numerous, but imperfect.
——— *corrugatum*	Ibid	Ibid.	
Fusus ? granosus	Tertiary	Soomrow.	
——*læviusculus*	Ibid	Ibid.	
——*nodulosus*	Ibid	Ibid.	
——, or *Murex hexagonus*	Ibid	Ibid.	
Ranella bufo	Ibid	Ibid.	
Rostellaria rimosa M. C., XCI., not Lamk	Ibid	Ibid.	
———*rectirostris*, Lamk	Ibid	Ibid.	
Strombus deperditus	Ibid	Ibid.	
———*nodosus*	Ibid	Ibid.	
Cassis sculpta	Ibid	Ibid.	
Buccinum pumilum	Upper Secondary ?	Mhurr.	Found in a mass of white marl.
Turbinellus bulbiformis	Nummulitic group.	Wagé-ké-pudda.	Found in vast quantities, and sometimes very large.
——— *affinis ?*	Tertiary	Soomrow.	
Mitra scrobiculata ? Brocchi	Ibid	Ibid.	
——*fusiformis*	Ibid	Ibid.	
Voluta jugosa	Ibid	Ibid	Among the most numerous fossils found at Soomrow.
———*dentata*	Ibid	Ibid,	
Cypræa depressa	Nummulitic group.	Baboa Hill.	
———*humerosa*	Tertiary	Soomrow.	

——*prunum*	Ibid.	Eyerau.	
——*digona*	Ibid.	Soomrow.	
——*nasuta*	Ibid.	Ibid.	
Seraphs	Nummulitic group.	Baboa Hill.	An imperfect cast.
Terebellum obtusum	Tertiary	Soomrow.	
Oliva pupa	Ibid.	Ibid.	Found in great quantities.
Conus brevis	Ibid.	Ibid.	Very numerous.
——*militaris*	Ibid.	Ibid	
——*catenulatus*	Ibid.	Ibid.	
——*marginatus*	Ibid.	Ibid.	
Belemnites canaliculatus ? Schlotheim	Upper Secondary.	Charee.	
————	Ibid.	Ibid.	
Nautilus hexagonus ? M. C., DXXIX.	Ibid.	Ibid.	
Ammonites Herveyii, var. M.C., CXCV.	Ibid.	Ibid.	Ammonites are exceedingly numerous throughout the Upper Secondary district, and are generally loose on the surface. In the text (p. 318) eight species are mentioned as new, but on further examination two of them have been ascertained to be only varieties.
————*elephantinus*	Ibid.	Ibid.	
————*formosus*	Ibid.	Ibid.	
————*lamellosus*	Ibid.	Ibid.	
———— *Opis*	Ibid.	Ibid.	
————*arthriticus*	Ibid.	Ibid.	
———— *ignobilis*	Ibid.	Ibid.	
———— *corrugatus ?* M.C., CCCCLI.	Ibid.	Ibid.	
———— *armiger*	Ibid.	Ibid.	
Nummularia acuta	Nummulitic group	Luckput.	Nummularia are so abundant as almost to compose a large tract on the north-west frontier of the province.
————*obtusa*	Ibid.	Wagé-ké-pudda.	
Fasciolites, (Parkinson) elliptica	Ibid.	Ibid. Baboa Hill.	

Plants from the Sandstone and Clay, with beds of coal: pp. 312, 317.

*Described by Mr. J. Morris.**

Ptilophyllum.

Stem — ? Fronds pinnate; pinnæ closely approximated, linear, lanceolate, more or less elongate, imbricate at the base, attached obliquely; base semicircular or rounded; veins equal, slender, parallel.

We have ventured to form these fossils into a distinct genus, conceiving that the circumstances of the oblique insertion of the pinnæ and their overlapping each other at the base, are characters too important to admit of their being united to the genus *Zamites*, to which somewhat similar fossils have hitherto been referred; the *Z. pectinata* of the Fossil Flora belongs to this genus, and a careful revision of the fossil *Cycadeæ* may probably discover other species having this mode of attachment; from the structure of the frond they may, however, be considered to belong to *Cycadeæ*, and to differ from *Zamites* in the oblique insertion of the pinnæ at the base, and from *Coniferæ* by the absence of a primary vein in the pinnæ.

Ptilophyllum acutifolium.

Frond pinnate; pinnæ narrow, linear-elongate, acute at the apex.

This species differs from the *Z. pectinata* of the Fossil Flora, in its pinnæ being narrower, longer, and more acute; and more nearly resembles the *Polypodites pecteniformis* of Sternberg.

P. Cutchense.

Frond pinnate; pinnæ short, scarcely overlapping at the base, apex obtuse.

This specimen has been also referred to the genus from its pinnæ (although wider apart than in the other species) having apparently a rounded base; but the absence of all trace of venation in this fossil must render its correct determination very doubtful. It resembles in form the *Z. Bucklandii* of Sternberg, parts 5 and 6, t. 23, f. 2, or even *Z. taxina* of the Fossil Flora; and it might also be compared to some pinnatifid Polypodiums, as *P. plumula* and *P. taxifolium.*

It is much to be regretted, that more numerous and better-preserved portions of these specimens have not been obtained, so as to compare them more rigidly with the already known forms of fossil vegetation; for it is remarkable the analogy that some of them present to the Stonesfield slate plants.

Lycopodites affinis.

* The plants are stated in p. 314 to consist of ferns and reeds, but when the Memoir was passed through the press the specimens had not been examined by Mr. Morris.

Stem ——— ? branches linear-elongate, leaves distichous, alternate, ovate-lanceolate, acuminate, adnate at the base.

This specimen has been referred to Lycopodites from its resemblance to the barren portions of *Lycopodium Jussieni* and *L. volubile*.

——— ———,

These specimens were probably portions of stems belonging either to *Equisetites* or some monocotyledonous plant.

Fucoides dichotomus.

Frond compressed ? dichotomous ; branches unequal, patulate, apex obtusely rounded.

Shells from the Upper Secondary Formation described by Mr. James de Carl Sowerby.

Pholadomya ? inornata. Transversely elongate, ovate, gibbose, concentrically corrugated ; beaks very near the anterior extremity ; longitudinal ribs very obscure, rounded. Width 1½ inch, length nearly 11 lines.

Loc. near Charee.

Pholadomya granosa. Ovate, subtriangular, gibbose, ornamented with four or five rows of transversely-elongated and but slightly-elevated tubercles ; the anterior side nearly straight-flattened, the posterior produced ; beaks very prominent. Length 2 inches, width the same.

Loc. near Charee.

Pholadomya angulata. Subtrigonal, gibbose, ornamented with four or five sharp ribs, which are most prominent near the edge ; anterior side straight, nearly flat. Length and width equal ; in some specimens 2 inches.

Ph. angulata approaches *Ph. Murchisoni* var. of Phillips. (Geol. of Yorks., Pl. VII. f. 9.)

Loc. near Charee.

Amphidesma ? ovale. Transversely elongate, ovate, convex, slightly wrinkled, anterior side small, truncated, distinguished from the rest of the shell by a gentle depression ; posterior extremity rounded, rather pointed. Length 11 lines, width 1 inch 4 lines.

Loc. near Charee.

There is no proof whatever that either this or the following belong to the genus *Amphidesma* ; they are, however, very nearly related to *A. donaciforme* and *A. securiforme* of Phillips.

Amphidesma ? hians. Transversely elongated, convex, slightly wrinkl-

ed ; sides gaping ; the anterior small, separated from the rest of the shell by an obscure depression ; the posterior rounded, a little flattened. Length 1 inch, width more than $1\frac{3}{4}$ inch : the specimen being broken we have not the measure complete.

Loc. near Charee.

Corbula lyrata. Rounded, triangular, convex, transversely ribbed ; ribs about 15, prominent, rounded ; posterior side of the larger valve formed into a distinct lobe, convex, nearly smooth—the beak of the same valve much incurved, the margin toothed. Length and breadth nearly equal, sometimes exceeding half an inch.

Occurs grouped in dense masses with *Trigonia Pullus*, a smooth *Uncula*, &c.

Loc. near Charee.

Astarte unilateralis. Transversely obovate, anteriorly truncated, convex, rather flattened and marked with 8 or 9 concentric rugæ near the beaks. Anterior side at right angles with the hinge line ; lunette concave, ovate, pointed. Width greater than the length, but variable in proportion, generally about $1\frac{1}{2}$ inch.

Loc. near Charee.

Astarte pisiformis. Nearly globose, with pointed beaks ; marked with 8 or 9 sharp transverse ridges ; edge toothed. Length 3 lines.

Loc. near Charee.

Trigonia costata, var. This shell varies slightly both in form and markings—generally the form is between that of *T. costata*, Parkinson or M. C. t. 85 ; and *T. elongata*, of M. C. t. 431 ; which Lamarck, apparently with justice, considers to be but one species.

Loc. near Charee.

Trigonia Pullus (M. C. t. 508, f. 2, 3.) ? The markings on the posterior side are not so regular as in the English specimens, but there is no other difference.

Loc. near Charee.

(Fossils from the Upper Secondary Formation, Cutch.)

Cucullœa virgata. Transversely elongato-quadrate, with projecting incurved beaks, very convex, marked with many longitudinal irregular, sharp ribs ; posterior margin obliquely truncated. Length $1\frac{1}{2}$ inch, width $2\frac{1}{4}$ inches.

Loc. Between Hubbye and Joorun.

Nucula tenuistrata. Obliquely oval, finely striated concentrically; beaks close to the anterior extremity. Length 4 lines, width 5 lines.

Specimens very imperfect, along with *Cucullæa virgata*

Loc. Between Hubbye and Joorun.

Nucula ? cuneiformis. Transversely elongate-elliptical, gibbose, smooth; beaks close to the anterior extremity, small, incurved. Length 6 lines, width 10 lines.

Loc. near Charee.

Pecten partitus. Broad, short-elliptical, depressed, marked with two concave radii, which divide the surface into three parts, both externally and internally, the lateral parts being flattened; concentrically and minutely waved, waves alternately larger and smaller; ears small, nearly equal. Length 6 lines, width 5 lines.

Loc. Hubbye Hills.

Plicatula pectinoides, (M. C. t. 409.). If this differ at all from the British species, it is in having rather more the habit of an *Ostrea*, which is apparent in the expansion of the edge.

Loc. near Charee.

Exogyra conica, (M. C. t. 26 and 605.). The few specimens most detached from the matrix appear not to be quite so deep as those figured in the Mineral Conchology.

Loc. Katrore Hills.

Ostrea carinata (Lam. Hist. Nat. VI. 216. M. C. 365.) ? The specimens being generally much concealed in the stone or broken, the determination of the species is not possible; the most perfect individuals resemble the young state of *O. carinata*, but that species is so near in some slates to *O. gregaria*, (M. C. t. 111.) and *O. solitaria* (M. C. t. 468.), that fragments cannot be distinguished.

Loc. near Charee.

Ostrea Marshii, (M. C. t. 48.). The *O. Marshii* varies so much in different localities, that we find no difficulty in referring this shell to that species, although the plaits are more numerous than usual.

This specimen is accompanied with an imperfect *Plicatula.*

Loc. Katrore Hill.

Terebratula intermedia, (M. C. t. 15. f. 8.) *var.* A small specimen, and rather more deeply plaited than most of the European varieties of the species.

Loc. near Charee.

Terebratula biplicata, (M. C. t. 90 and 437, f 2, 3.) *var.* A variety of this variable species found in the red chalk at Hunstanton, is precisely simi-

lar in form to our specimen, except that it wants the angle on each side of the beak which is here obscurely visible.

Loc. Jooria Hill.

Terebratula Sella, (M. C. t. 437, f. 1.) *var.* A rather longer shell than the British fossil, and deficient in the central plait which most generally occurs in full-grown individuals of that species.

Loc. Pass of the Hubbye Hills.

Terebratula concinna, (M. C. t. 83, f. 6.) ? A larger shell than the one figured in M C. and not so neat, but hardly possessing any character sufficiently strong to mark it as a species ; there are, however, rather fewer plaits.

Loc. Jooria Hill.

Terebratula nobilis. Tetrahedral, rounded, sharply plaited ; plaits about 16, extending to the beaks, 4 or 6 of them much elevated along the middle of the disk ; beaks small, adpressed ; sides concave near the beaks.

A large handsome species ; when young the general form is depressed, but the middle is even then much elevated. Length and width, each $1\frac{3}{4}$ inch, depth of the valves united, sometimes more than 2 inches.

Loc. near Charee.

Terebratula dimidiata, (M. C. t. 277. f. 5.)? Whether this be *T. dimidiata* or *T. inconstans*, (M. C. t. 277, f. 4.) is a question the specimens are not perfect enough to settle. The flattened form of the specimen figured agrees with that of *T. dimidiata*, but the beaks of our specimens appear too much incurved (perhaps from pressure) and so to approach *T. inconstans.*

Loc. Jooria Hill, and near Charee.

Terebratula major. Transversely obovate, gibbose, plaited ; plaits angular, extending to the beaks, about 30, half of them on one side of the front slightly raised ; beak of the larger valve prominent, slightly incurved. A larger species than the last, of the same family, well distinguished by its width and even surface. Length, $1\frac{3}{4}$ inch, width $2\frac{1}{4}$ inches, depth of the valves united $1\frac{1}{2}$ inch.

Loc. near Charee.

(Fossils from the Upper Secondary Formation, Cutch.)

Buccinum pumilum. Ovate, pointed, transversely striated ; spire small ; whorls 4, smooth in the middle, slightly convex ; aperture ovate, pointed at both extremities. Height 3 lines, diameter 2 lines.

Loc. Mhurr.

Belemnites canaliculatus, Schloth. (Zieten, t. xxi. f. 3.) ? The fragments we have of this Belemnite agree well with Zieten's figure of *B. canaliculatus*, which is very probably not distinct from *B. sulcatus* of Miller (Geol. Trans., 2nd Series, vol. ii. part 2, p. 59, Pl. VIII f. 3).

Loc. near Charee.

Belemnites ——— ? A nearly cylindrical fragment without a sulcus. Very like *B. elongatus* of Miller.

Loc. near Charee.

Nautilus hexagonus (M. C. t. 529) ? Flatted spheroidal, with a very small umbilicus; front approaching to flat; sides rather conical; septa 15 in a whorl; aperture wider than long; siphuncle unknown. Diameter $3\frac{1}{4}$ inches, thickness $2\frac{1}{4}$ inches, length of the aperture $1\frac{1}{2}$ inch.

This differs from *N. hexagonus* in having a smaller umbilicus and in being more rounded. It wants the line that occurs in the middle of the front of *N. lineatus*, which it nearly resembles.

Loc. near Charee

Ammonites Herveyi, (M. C. t. 195, Zieten, 19. t. xiv. p. 3.) *var.*

This differs from the English specimens only in having a wider umbilicus. It agrees well with Zieten's figure, which differs a little from the English specimens, to which *A. macrocephalus*, figured by the same author at Tab. 5. f. 1 and 4., approaches nearer.

Loc. near Charee.

Ammonites elephantinus. Approaching to globose, with a very wide umbilicus exposing the inner whorls; whorls obtusely angular at their sides, crossed by very prominent rounded costæ, which divide into two as they pass over the front; aperture transversely elongated, gently arched. Diameter 4 inches, thickness $2\frac{1}{2}$ inches, length of aperture above an inch.

Loc. near Charee.

Ammonites formosus. Discoid, with a rounded edge, umbilicate, radiated; umbilicus narrow, acutely conical; radii numerous, slightly elevated, obscure near the umbilicus, often forked near their commencement, passi g in a direct course over the front; aperture sagittate, with truncated angles. Diameter 5 inches, thickness $2\frac{1}{4}$ inches, length of aperture $1\frac{1}{2}$ inch.

Loc. near Charee.

Ammonites lamellosus. Discoid, thick, with a rounded margin, umbilicate, radiated; umbilicus narrow, exposing a small portion of each inner whorl, smooth; radii numerous, elevated into obtuse lamellæ, commencing with a curve upon the edge of the umbilicus, often forked upon the

middle of the sides, bent forward as they pass over the margin. Diameter 4 inches, thicknes $1\frac{3}{4}$ inch.

Loc. near Charee

Ammonites Opis...Discoid, compressed, with an obtuse edge, radiated; inner whorls one-third exposed; whorls slightly convex on their sides, their inner edge rounded; radii commencing with a curve at the inner edge of the whorls, numerous, prominent, rounded, often forked near the middle, slightly bent forward as they pass over the front; aperture elliptical. Diameter $4\frac{1}{4}$ inches, thickness $1\frac{1}{4}$ inch, length of aperture $1\frac{1}{4}$ inch.

Loc. near Charee.

Ammonites arthriticus. Discoid, thick, with convex whorls and a rounded margin, tuberculated and ribbed; whorls half-exposed, about 4, their inner margin smooth; tubercles large, near the middle of the sides of the whorls, about 12 in each whorl; ribs prominent, rounded, 3 or 4 from each tubercle and sometimes an intermediate one; aperture nearly circular, completed 3 or 4 times in each whorl with a thickened edge. Diameter $2\frac{1}{2}$ inches, thickness 1 inch.

Loc. near Charee.

Ammonites ignobilis. Discoid, depressed, umbilicated, keeled, radiated; front rounded with a slightly prominent entire keel; umbilicus small, with squarish edges, exposing a small portion of the inner whorls; radii covering half the whorl, in pairs or forked, commencing and terminating with obscure tubercles, waved; aperture sagittate, narrow. Diameter nearly 3 inches, thickness 10 lines. Length of the aperture $1\frac{1}{4}$ inch.

Loc. near Charee.

Ammonites corrugatus (M. C. t. 451, f. 3.)? An imperfect specimen rather more strongly ribbed than the one figured in Mineral Conchology.

Loc. near Charee.

Ammonites Armiger. Discoid, inner volutions exposed; inner whorls radiated and furnished with a row of tubercles on their sides; outer whorl with a row of tubercles near the inner edge, and a row of spines near the outer edge on each side,—the tubercles and spines connected by thick ribs; margin flat; aperture oblong, squarish. Diameter 7 inches.

Strongly resembling *A. perarmatus* (M. C. t. 352.), but the whorls increase more rapidly in size, and the aperture is longer. Probably *A. Catena*, *A. perarmatus*, and this are only varieties of one species.

Loc. near Charee.

Crinoidal stems, apparently of 3 species.

Loc. near Charee.

(Fossils from the Nummulitic Limestone and Marl, Cutch, p. 321.)

Cardium intermedium. This shell, of which we have only casts, is very near in form to *Cardita intermedia* of Lamarck; the hinge, as we learn from the impression, however, wants the long marginal tooth, which marks the genus *Cardita.* Length 1 inch, width the same.

Loc. Baboa Hill.

Cardium ambiguum. The furrows upon the surface of this cast are deeper than they would be in a cast from the European *C. serratum;* which, in the general form of the shell and number of furrows it resembles more strongly than it does the *C. lævigatum* of the Indian Seas. Length 2 inches 1 line, width 1 inch 10 lines.

Loc. Baboa Hill.

Arca hybrida. Transversely oblong, oblique, longitudinally costated; costæ strongly marked with the lines of growth,—those on the anterior side, furrowed along the middle; area narrow. Length 11 lines, width 14 lines.

Nearly related to the recent *A. rhombea*, but with a narrower area between the beaks, approaching to *A. Indica* of Linnæus.

Loc. Baboa Hill.

Pectunculus Pecten. Orbicular, convex, ribbed; ribs about 30, radiating, crenated by the lines of growth; hinge-line short. Length 10 lines, width 11 lines.

Very nearly like *P. pectinatus* of Lamarck, but with more numerous and more distinctly granulated rays.

Loc. Baboa Hill.

Nucula Baboensis. Transversely oval, convex, smooth ?; lunette sunk; beaks nearest the anterior side. Length $\frac{3}{4}$ inch, width 1 inch.

Nearly resembling *N. Bowerbankii* (Geol. Trans., 2d series., vol. v. 136. Pl. 8. f. 11.) but not truncated or pointed below the lunette.

Loc. Baboa Hill.

Pecten lævi-costatus. Short, smooth, radiated; radii about 20, large, equal to the spaces between them; ears large; inside furrowed. Length 1 inch 4 lines.

Length a little less than the width, but the ears enter so much into the sides that they confine the beaks into a small angle, and make the form appear more transverse than it really is.

Loc.

Ostrea callifera. (Lam. Hist. Nat. vol. vi. p. 218. Deshayes, Coq. Fossiles des Env. de Paris, vol. i. 339. Pl. LI., f. 1, 2.) ? A very ponder-

ous shell, with only a shallow cavity for the animal. Length $3\frac{1}{2}$ inches, width $2\frac{3}{4}$ inches, thickness of the shell above an inch and a quarter.

Loc. Wagé-ké-Pudda.

Ostrea orbicularis. Orbicular, plaited; both valves convex; plaits angular, repeatedly forked; surface imbricated. Length and width about two inches, resembling *O. Flabellulum*, but more regularly and finely striated. See p. 323.

Loc. Luckput.

Neritina grandis. Short-conical, smooth; spire concealed; aperture very large; base convex, its margin rounded. Diameter 3 inches, height $1\frac{1}{2}$ inch.

This resembles *N. Schmidelliana*, but has a larger aperture in proportion and a less excentric apex; it is also higher. The specimen is little more than a cast, and does not exhibit the edge of the inner lip, but still it shows the attachment of the ligament projecting from the lower surface, and that the aperture occupied more than half the base.

Loc. Wagé-ké-pudda.

Globulus obtusus. Globose, with a very short spire; whorls about 6; aperture ovate-elongated, pointed above; umbilicus open, narrow. Height 1 inch, diameter the same.

The short spire of 5 whorls gives this shell a very blunt aspect.

Loc. Baboa Hill.

Turbinellus bulbiformis. Short-fusiform, smooth; spire pointed; whorls 6, flattened in the middle; aperture narrow, pointed at both ends. Height above 7 inches, diameter 5 inches.

Resembles *T. Napus*, but has a more elongated spire.

Loc, Wagé-ké-pudda.

Cypræa depressa. Obovate, with a blunt spire and a flattened space across the middle of the back. Length $3\frac{1}{2}$ inches width 2 inches 7 lines.

This being only a cast, we can give but a very imperfect description.

Loc. Baboa Hill.

Nummularia acuta. Depressed, sides conical, decreasing in proportional height by age; when young radiated, when full-grown granulated; volutions and septa numerous; edge sharp. Diameter 5 lines, thickness $1\frac{1}{2}$ line.

Distinguished from most other species of Nummularia by the conical form of the sides.

Loc. Luckput.

Nummularia obtusa. Irregularly orbicular, thick, smooth, sides flattened: margin rounded; volutions and septa very numerous. Diameter of

the largest individual 10 lines, thickness nearly five lines. A remarkably thick species.

Loc. Wagé-ké-pudda.

Lycophris Ephippium. Orbicular, depressed, curved so as to resemble a saddle, with a gently elevated umbo on each side; margin thick, obtuse, with a narrow waved keel in the middle; grains on the surface small and equal. Diameter 1½ inch, thickness 3 lines.

Lycophris dispansus. Lenticular, thick, with a very thin, expanded, sharp-edged margin; grains on the surface largest in the centre of the disk. Diameter ½ an inch.

These two fossils may possibly be different stages of growth of the same species; for there occur along with them many curved plates which are intermediate in form. The grains on the surface are the projecting extremities of internal columns, not merely granulations in the substance of the fossil, as in some species of Nummularia. The internal structure is totally different from that of Nummularia, as it is only on the inner surfaces of the two plates that any appearance of a spiral or concentric series of cells can be traced. In p. 321 these fossils are assigned to the genus *Orbitolites.*

Loc. Both species very abundant at Baboa Hill and Wagé-ké-pudda.

Fasciolites (Parkinson) *elliptica.* Elliptical with blunt extremities, bands curved. Length 5½ lines, diameter 3 lines.

Several species of this genus occur in the tertiary formations of Europe, but they are longer in proportion to their thickness.

Loc. Wagé-ké-pudda and Baboa Hill.

Echinus dubius. Orbicular, depressed; areæ granulated, concave, and nearly free from grains along the middle; the larger furnished with two rows of tubercles near each side; the lesser with one row on each side; pores of the ambulacra in numerous, arched rows. Diameter about 3 inches, height about 1¼ inch.

This has apparently imperfect tubercles, and is much longer than *Cidarites variolaris,* Brongn., which however it much resembles.

Loc. Baboa Hill and Wagé-ké pudda.

Galerites pulvinatus. Orbicular, depressed, spheroidal, covered with minute tubercles. Ambulacra obscure beneath, crossed by grooves above. Diameter 3¼ inches, height 1 inch 10 lines.

A species much like *G. depressus,* Lam., but more convex and ten times the size of it.

Loc. Baboa Hill.

Clypeaster affinis. (Goldfuss, p. 134. t. 43, f. 6.)? Our specimen appears to be more orbicular than the *C. affinis* of Goldfuss, but it is too

imperfect to be determined,—the posterior half being nearly all broken away. Length about $2\frac{1}{4}$ inches, width 2 inches, height 1 inch.

Loc. Baboa Hill.

Clypeaster varians. More or less obovate, hemispherical; base slightly concave in the middle; ambulacra elongated; anus transverse. Length $2\frac{1}{2}$ to 3 inches, breadth 2 to $2\frac{1}{2}$ inches, height $1\frac{3}{4}$ to 2 inches.

C. Bonei of Munster, (Goldfuss, 131. t. 41. f. 7.) resembles this, but is more depressed, and has a circular anus.

Loc. Baboa Hill and Wagé-ké-pudda.

Spatangus obliquatus. Gibbose; emarginate at the front; behind obovate, rather acuminated, and truncated obliquely upwards. Ambulacra deeply sunk in 3 large and 2 smaller ovate pits; base slightly convex. Length $2\frac{1}{2}$ inches, width 2 inches, height $1\frac{1}{2}$ inch.

Strongly resembling *S. Bucklandii*, (Goldfuss, 154, t. 47. f. 6.) it is however much larger, and has unequal ambulacra. In this and the allied species with concave ambulacra there is a reticulated band surrounding the ambulacra, which deserves attention.

Loc. Baboa Hill.

Spatangus acuminatus. (Goldfuss, 158. t. 49. f. 2.)? Our specimen is not quite so much elevated posteriorly as the figure given by Goldfuss, neither is it quite so wide; in both these circumstances it approaches to *S. lacunosus*; but it is laterally crushed, which may account for the difference. Length $1\frac{1}{4}$ inch, width nearly the same, height 10 lines.

Loc. Baboa Hill.

Spatangus elongatus. Elongated, ovate, depressed; front emarginate; base convex; ambulacra concave, with two of the rows of pores nearly central; apex excentric; mouth remote from the margin. Length nearly $2\frac{1}{2}$ inches, width $1\frac{3}{4}$ inch, height 1 inch.

The two posterior ambulacra and the posterior portion of the shell are broken; the description is therefore incomplete.

Loc. Baboa Hill.

Clypeaster oblongus. (*C. scutiformis* ? Lam.) Oblong, subpentagonal, convex above, concave beneath; ambulacra very broad, obtuse. Length $2\frac{3}{4}$ inches, breadth above 2 inches, height 7 lines.

The specimen is too much mutilated to show the anus. It is more pentagonal than *C. scutiformis*, to which we have before referred it.

Tertiary Formation. Loc. Between Joongrea and Kotra.

Clypeaster depressus. Pentagonal, much depressed; ambulacra oval; anus very near the margin. Length in the oldest individual about 2 inches, breadth rather less, height about $\frac{1}{2}$ inch.

This differs from *C. Laganum* in the position of the anus, which in that

species is half-way between the mouth and the margin, in the greater size of the papillæ, and in being much thinner.

Tertiary Formation. Loc. Soomrow.

(Fossils from the Tertiary Formations, Cutch.)

Serpula ? recta. An oval, free, slightly-waved shelly tube, which we have provisionally called a *Serpula*, although it is more like the tube of a *Teredo;* but it appears to have been formed in loose sand. Diameter $\frac{3}{4}$ inch.

Loc. near Kotra.

Siliquaria Grantii. Spirally striated ; striæ crossed by numerous cracks ; fissure composed of a series of oval pores. It differs from the recent *S. anguina* only in the smallness of the pores which form the fissure.

Loc. Borders of the Runn.

Balanus sublævis. Subcylindrical with curved valves, nearly smooth. Operculum ? Diameter 1 inch, height 9 lines. Parasitic upon shells.

Loc. Soomrow.

Corbula trigonalis. Trigonal, with the front rounded, gibbose, antiquated ; valves nearly equal, posterior side truncated obliquely with a carina upon each valve, and pointed ; umbones equal, central. Length 6 lines, width 8 lines ; but these proportions vary.

Loc. Borders of the Runn.

Corbula rugosa. (Lam. vol. v. 497.) This differs from the last in being a much wider shell, with more regular and prominent laminæ upon the surface. Length $2\frac{1}{2}$ lines, width $3\frac{1}{2}$ lines.

Loc. Borders of the Runn.

Tellina exarata. Ovate, compressed, ornamented with many erect concentric laminæ ; the posterior extremity pointed, much bent. Length nearly $\frac{3}{4}$ of the width, which is nearly 2 inches.

Strongly resembling *Tellina virgata*, (Lam. Hist. Nat. vol. v. 52.) but wider and more bent.

We have ventured (contrary to our usual custom) to complete the surface of this shell, although much has been lost from the specimen.

Loc. Soomrow.

Venus granosa. Obovate, truncated, posteriorly convex, ornamented with erect concentric laminæ, crossed by numerous striæ which cut these (near the margin) into rounded grains ; lunette broad, pointed, convex ; beaks nearest the anterior extremity. Length $1\frac{3}{4}$ inch, width more than 2 inches.

This belongs to the same family of *Venus* as *V. Corbis*, and *V. puerpera*, and is scarcely distinguishable from *V. puerpera*, *β*. (Lam. Hist. Nat. vol. v. 585.)

Loc. Soomrow.

Venus cancellata. Obovate, approaching orbicular, gibbose, ornamented with erect concentric laminæ, and many longitudinal striæ ; lunette wide, pointed, convex ; beaks nearest the anterior extremity. Length 1¾ inch, width 1 inch 11 lines.

This resembles the last, except that it is rounder, with thinner laminæ, which are not cut into round grains.

Loc. Soomrow and Kotra.

Venus non-scripta. Tranversely oval, convex, smooth, concentrically undulated ; lunette elongated, pointed, concave ; beaks nearer the anterior extremity. Length 1 inch 4 lines, width 1¾ inch.

A smooth and thin shell, with little of the aspect of a Venus.

Loc. Soomrow.

Pullastra ? virgata. Transversely oval, elongated, decorated with smooth concentric ridges ; beaks nearest the anterior extremity. Length 13 lines, width 1 inch 7 lines.

Several recent species of *Pullastra* are like this, but no described one appears to be identical with it.

Loc. Soomrow.

Cardita intermedia, (Lam. Hist. Nat., vol. v. part 1. 23. Brocchi. vol. ii. 520. t. 12, f. 15.) ? This strongly resembles several species of *Venericardia*, Lam.

Loc. Soomrow.

Cardium triforme. Orbicular, ventricose, longitudinally striated ; anterior side covered with round granules formed by decussating striæ ; the posterior side crossed by oblique sets of reflected ridges. Length and width 1 inch 4 lines.

Somewhat resembling the recent *Cardium æolicum.*

Loc. Soomrow.

Arca radiata. Transversely elongated, oblique, rather convex, radiated ; radii elevated, furrowed ; beaks almost close, nearest the anterior side.

Length, 7 lines, width 1 inch.

Loc. Soomrow.

Arca tortuosa ? Linn. This is only a fragment, and what there is, seems to differ from the recent *Arca tortuosa* in the degree of curvature,

Loc. Soomrow.

Pecten Somrouensis. Obovate, convex, radiated; radii about 24, squamose, subdivided, in one valve into 3, in the other into 5: ears unequal, striated, and squamose. Length 2 inches 2 lines, width nearly 2 inches.

In form this *Pecten* approaches to *P. varians*, but in the structure of the surface it is like *P. plebeius* of the Crag, and many recent species.

Loc. Soomrow.

Pecten articulatus. Orbicular, with pointed beaks, depressed, radiated; radii about 28, simple, rounded, crossed by distant scales; ears large, striated, and squamose. Length in an old specimen about 1 inch 8 lines, width 1 inch 6 lines.

The radii when the scales are worn off appear jointed.

Loc. Bank of the Runn.

Gryphæa globosa, (M. C. t. 392, *Ostrea vesicularis*, Lam. Hist. Nat. vol. vi. part I. p. 219. Cuv. and Brongn. Env. de Paris, 383, t. 3. f. 5. *Podopsis gryphæoides*, Lam. Hist. Nat. vol. vi. part I. 195).

This exactly agrees with old specimens found in the chalk of Norfolk.

Loc. Kotra.

Ostrea angulata. Suborbicular, arched, compressed, plaited; plaits angular, numerous, branched towards the margin; laminæ of increase regular, distant, raised at their edges. Length about 1¼ inch, width the same.

Loc. Kotra.

Ostrea Flabellulum, (M. C. t. 253 Lam. Hist. Nat. vol. vi. part 1. 215. *Chama plicata*, Brander, 84 and 85.). The identity of this oyster with the *O. Flabellulum* of the tertiary formations of Europe is unquestionable.

Loc. Cheeosir.

Ostrea tubifera. Orbicular; laminæ of increase thick, raised into a few large, nearly erect tubes arranged in about 6 rows. Diameter 2 inches.

Loc.

Ostrea Lingua. Much elongated, smooth, approaching to even; upper valve flat or concave, the other very convex; squamoso-fimbriated at the edges. Length 2½ inches, width 1½ inch.

So variable are *Ostreæ* in form and so much do the species resemble each other, that it is hardly possible to define some of them clearly. That before us is very like *O. tenera* (M. C. t. 252, f. 2 and 3.), yet in

the depth of the attached valve it approaches to *O. Meadii* (M. C. 252, f. 1 and 4.), but is not waved like that.

Loc. near Joonagrea and Kotra.

(Fossils from the Tertiary Formations, Cutch.)

Bulla lignaria, Linn. This agrees perfectly with the recent species as far as we can ascertain from specimens which are not perfect ; but it is quite distinct from both the fossil shells described by Deshayes under the same name.

Loc. Soomrow.

Natica obscura. Globose, umbilicate ; spire small, pointed ; whorls about 5, convex, flattened, and ornamented at the upper edge with fine diverging plaits ; umbilicus partly filled with a semi-cylindrical, obliquely-truncated callus. Height $1\frac{1}{4}$ inch, diameter the same.

Nearly related to *N. Epiglottina*, Lam., but distinguished by the flattened upper margins of the whorls ; and to *Nerita canrena* of Brocchi, vol. ii. 296.

Loc. Soomrow.

Natica callosa. Obliquely depressed ; spire small, hardly projecting ; umbilicus covered by the thickened and expanded inner lip : aperture very large. Height 2 inches, diameter $1\frac{3}{4}$ inch.

A very distinct species.

Loc. Soomrow.

Globulus ? anguliferus. Oblong, obliquely striated : spire produced ; whorls about 4, with their sides and upper edges flattened ; umbilicus open, rather large. Height and diameter $\frac{3}{4}$ inch.

The elevated lines or striæ advancing towards the aperture as they descend the sides of the whorls form a peculiar character. The aperture appears to be small.

Loc. Borders of the Runn.

Solarium affine. Convex above, flattish beneath, marked with diverging striæ on both sides ; whorls 4 or 5, with a deflected entire carina, above which are 4 furrows placed at nearly equal distances, and below, 2 furrows near the carina, and 2 near the umbilicus, which is large, with a crenated edge. Diameter $1\frac{1}{2}$ inch, height $\frac{1}{2}$ inch.

Perfectly distinct from *Solarium perspectivum*, which it somewhat resembles.

Loc. Soomrow.

Trochus cognatus. Conical with straight sides ; whorls numerous, or-

namented with several rows of granules, which sometimes (especially towards the apex) are united by elevated lines, and a row of tubercles upon the inferior edges of the upper whorls, succeeded by 2 rows upon the middle volutions, and crenated ridges of slight elevation on the rounded border of the lowest whorls ; base flat, concentrically furrowed, containing a thick plait within

Like *T. maculatus* ; height 2 inches, diameter of the base nearly the same.

Loc. Soomrow.

Turritella angulata. Turrited, conical ; whorls convex, decorated by about 7 carinæ, of which the lowest but one is much the most prominent. Height $1\frac{1}{3}$ inch, diameter 8 lines.

Loc. Soomrow.

Turritella assimilis. Turrited, whorls convex, ornamented with 6 or 7 carinæ, of which 2 or 3 are obscure, the 2d and 5th being prominent. Height $1\frac{1}{2}$ inch, diameter 5 lines.

A smaller, narrower species than the last.

Loc. Soomrow.

Terebra reticulata. Subulate ; sides of the whorls flat, cancellated ; a narrow upper portion of each whorl divided from the lower in the form of a band by a ridge and furrow ; beak short, curved.

In some specimens the transverse or spiral lines are less conspicuous, particularly on the band and the upper half of the whorl.

Loc. Soomrow.

Cerithium rude. Subulate, with curved sides, ribbed and furrowed ; ribs numerous, cut across by about 5 square furrows, of which the uppermost is distant from the suture ; whorls 10 or 12, nearly flat, with an obtuse varix between each—the last varix very prominent ; aperture nearly round, with a canal at the upper angle ; inner lip thick, with a callus at the top ; beak broken. Height 2 inches 8 lines, diameter about 8 lines.

Loc. Soomrow.

Cerithium corrugatum. Subulate, ribbed and coarsely striated ; ribs numerous, arched, and prominent, crossed by deep striæ ; whorls 8 or more, rather convex, with a distinct varix upon each.

This has much of the contour of an elongated Fusus. The lip and beak are wanting in the only specimen found.

Loc. Soomrow.

Fusus? granosus. Short-fusiform, ribbed ; ribs about 12 upon each whorl, divided into grains by 6 or 7 transverse ridges, convex ; spire half the length of the shell ; beak suddenly contracted. Height 4 lines.

A pretty shell, much resembling some species of *Nassa* which occur in the Crag.

Loc. Soomrow.

Fusus læviusculus. Short, fusiform, ribbed, and striated; ribs irregular, mostly very short; whorls 6, angular; base conical; beak short. Height 10 lines, diameter 5 lines.

Loc. Soomrow.

Fusus nodulosus. Fusiform, elongated, ribbed and strongly striated; ribs short, broad, about 8, in the middle of each whorl; whorls 6 or 7, concave above, convex below; beak contracted.

Loc. Soomrow.

Fusus (Murex ?) hexagonus. Short-conical, with an elongated beak, 6-angled; whorls about 6, with 6 ribs on each, which form the angles of the spire, and are crossed by 3 strong ridges upon the spire, thickened where they cross, convex; beak suddenly contracted.

Loc. Soomrow.

Ranella Bufo. Conical, with 2 rows of thin expanded varices and several ribs, the whole crossed by 3 or 4 prominent and several intermediate thin ridges; whorls 7 or 8, convex; varices obtuse at their edges; aperture oval; beak short, oblique. Height 1 inch 4 lines, diameter 1 inch.

Nearly resembles *Ranella bituberculata* of Lamarck.

Loc. Soomrow.

Rostellaria rimosa, (M. C. 91. f. 4, 5, 6, *Strombus cancellatus*, Lam. Hist. Nat. vol. vii. t. 212 ?)

The fragment we have before us, is firmly imbedded in the stone, and we are not able to clear the lip so as to ascertain whether it be striated like the lip of the recent *Strombus cancellatus*, Lam., or smooth and thickened as in *Rostellaria rimosa* and *R. Fissurella*, Lam., &c.; of all these, the species nearest to the fossil is *R. rimosa* of the London Clay, which is easily distinguished from *R. Fissurella*, Lam., of the Paris Basin, by being striated all over, and having the canal continued nearly to the apex of the spire, but not curved back. From *Strombus concellatus*, Lam., this fossil is distinguished by having a tumid varix upon the last whorl, a character also of *Rostellaria rimosa*, and we are consequently induced to refer the Cutch shell to it rather than to *Strombus cancellatus*.

Linnæus and his immediate followers did not distinguish between the recent and fossil shells, although the recent one (*Strombus decussatus*, Lam.) has the lip striated within, and is placed by Lamarck in another genus, while Deshayes in the " Coquilles fossiles des environs de

Paris," unites the French fossil and the two English ones under one name, although they are perfectly distinct; probably he has not examined English specimens. We find the characters very constant, and easily observed when once pointed out. The analogous shells of Bordeaux are equally distinct. About the same size as *R. rimosa*, M. C., from Barton.

Loc. Soomrow.

Rostellaria rectirostris. (Lam. Hist. Nat. vol. vii. 192.) The elongated form induces us to refer this fossil to the recent *R. rectirostris*, in preference to any other species.

Loc. Soomrow.

Strombus deperditus. Turbinate, tuberculated, and transversely striated; tubercles united by a slight carina gradually increasing in size; lip thickened, produced above into a short pointed lobe. Height $2\frac{1}{4}$ inches, diameter 1 inch 4 lines including the wing.

Much like *Strombus Gallus*, Linn., and *S. bituberculatus*, Lam., but the tubercles are of an equal size on the last whorl and not much larger than on the spire. The aperture is not much dilated, so that the wing is rather small. It appears to be a very common shell in the Runn, but perhaps there are several species, as many of the specimens are so firmly attached to the stone, and so much concealed, that the distinguishing marks cannot be traced.

Loc. Soomrow.

Strombus nodosus. Turbinate, elongated, tuberculated, transversely and longitudinally striated; tubercles equal, numerous, prominent, obtuse. Height $1\frac{3}{4}$ inches.

Distinguished by the rounded tubercles, of which there are about 12 to each whorl—and the elongated spire.

Rare—we have seen but one specimen and that is very imperfect.

Loc. Soomrow.

Cassis (*Cypræcassis*, Stutchbury,) *sculpta.* Ovate, transversely sulcated; aperture narrow, the outer lip plaited, the inner smooth. Height $1\frac{3}{4}$ inch, diameter 1 inch.

Strongly resembling *Cassis* (*Cypræcassis*, Stutchbury,) *Testiculus* (*Bucc. Testiculus*, Linn.), but smoother, and with a narrower aperture.

Loc. Soomrow.

Turbinellus affinis. Subfusiform, swelled in the middle, ornamented with many transverse ridges and a row of flatted tubercles near the upper margin of each whorl; beak produced transversely, ribbed; columella 5-plaited. Height 4 inches, width 2 inches.

Very nearly related to *Turbinellus Scolymus*, Lam., but it is more elongated, has smaller tubercles, and 5 not 3 plaits on the columella.

Loc. Soomrow.

Mitra scrobiculata (Brocchi, vol. ii. 317. t. iv. f. 3.)? This is the same as the fossil found at Piacenza.

Loc. Soomrow.

Mitra fusiformis. Fusiform, pointed, striated; striæ distant, deep, punctated, suture entire; columella with 4 plaits. Height 2 inches, diameter 9½ lines.

Somewhat resembling *Mitra adusta* of Lamarck.

Loc. Soomrow.

Volupta jugosa. Fusiform, pointed, transversely striated, costated; costæ many, rounded, terminating in points above the suture; aperture elliptical, elongated; columella with 3 plaits. Height 2½ inches, diameter 1¼ inch.

This differs from *V. Magorum* of Brocchi, in the form of the ribs, and the small number of plaits upon the columella, and from *V. costata*, (M. C. t. 290.) in the form and in the greater number of the ribs.

Loc. Soomrow.

Voluta dentata. Turbinate, striated, spire short, conical, pointed; whorls crowned with tubercles which surround a concave space; aperture elongated; the outer lip thick, crenato-dentated within. Height 1 inch 7 lines, diameter 1 inch.

Loc. Soomrow.

Cypræa humerosa. Obovate, depressed with 3 protuberances upon the back, and one on each side. Length 2 inches, width 1½ inch.

Loc. Soomrow.

Cypræa Prunum. Oval, ventricose; aperture narrow, slightly curved with about 20 teeth on each side; base convex; beak small, not much produced; a very even shell. Length nearly 2 inches, width 1¼ inch.

Loc. Eyerau.

Cypræa digona. Ovate, ventricose, slightly depressed; base flattened on each side; beak expanded, prominent, with sharp edges; teeth on each side the aperture, above 20. An obscurely-marked species. Length 13 lines, width 9½ lines.

Loc. Soomrow.

Cypræa nasuta. Ovate-elongated, ventricose; beak projecting, large; posterior extremity of the lip produced; apex of the spire sunk. Length 10 lines, width 6 lines.

Loc. Soomrow.

Terebellum obtusum. Ovate, much elongated; spire 2 or 3 whorls, obtuse.

Length about 2 inches, width 6 lines.

This is more like the recent *T. subulatum* than the fossil *T. fusiforme.*

Loc. Soomrow.

Oliva Pupa. Elongated, subcylindrical, with a produced pointed spire, a broad smooth band at the base, and a slightly-plaited callus on the columella. Length 1 inch 9 lines, width 8 lines.

Loc. Soomrow.

Conus brevis. Short-conical; spire flat, with a produced apex marked with 4 concentric striæ decussated by the lines of growth; base ornamented with several small, rather distant ridges. Height 1¼ inch, diameter 1 inch.

Imperfect specimens are found, more than double the above diameter.

Loc. Soomrow.

Conus militaris. Conical, elongated, slightly contracted towards the edge of the spire, coloured by many triangular spots arranged in zigzag rows; spire flat, upper surfaces of the volutions concave; base nearly smooth. Height 1½ inch, diameter 11 lines.

This shell and the following retain traces in a remarkable manner of the original colouring.

Loc. Soomrow.

Conus catenulatus. Conical, elongated, coloured with transverse rows of white spots upon a dark ground—spire flat, elevated in the middle, concentrically striated, mottled with white, the edge sharp; the base obscurely furrowed. Length 1¼ inch, width 8 lines.

Loc. Soomrow.

Conus marginatus Conical, much elongated; spire conical, short, surrounded by an obtuse ridge from its base to its apex; base of the shell striated. Length 1½ inch, width 8 lines.

Loc. Soomrow.

IX.—*On certain Meteorological Phænomena in the Ghâts of Western India.**—*By Col.* Sykes, *F. R. S.*

In the proceedings of the Physical Section at the meeting at Newcastle, the incidental mention of the annual fall of very many feet of

* From the Report of the Ninth Meeting of the British Association for the Advancement of Science for 1839.

rain in certain localities of India, instead of a few inches, as is the case in Europe, caused, I was told, some surprise, and the expression of a doubt whether the fact had been ascertained with sufficient precision, and by competent persons. I was not present on the occasion alluded to, but the doubt having been brought to my notice subsequently, I lost no time in applying to a friend to procure for me the official meteorological records kept by order of the government of Bombay at the convalescent station of Mahabuleshwar, which records I knew would afford sufficient evidence to remove all doubts, at least so far as related to one locality; and I have now the pleasure of submitting the abstract of the Meteorology for 1834; the observations being made by Dr. Murray, the medical officer in charge of that station. The station is situated lat. 17° 58′ 53″ N. and long. 73° 29′ 50″ W., near the western scarp of the Ghâts, or mountain chain extending from Surat to Cape Comorin, and varying from 1000 to 8000 feet in height. The elevation of the table-land at Mahabuleshwar averages 4500 feet. The temperature of a spring is 65·5 Fahr., and the mean temperature of the air for three or four years is nearly the same. There is a good deal of forest along the Ghâts, but in belts and patches, so that the wood can have little effect on the phænomena which I am about to describe. In this table-land is the source of the celebrated Kistnah river, which runs across the peninsula.

The following table shows the state of the thermometer, fall of rain, &c., at the station:

Months.	Mean Temperature.	Mean Maximum.	Mean Minimum.	Mean Variation.	Fall of Rain in Inches.	Direction and force of the Wind. A. M.	Direction and force of the Wind. P. M.
January	65·7	71·2	60·2	11·	—	E. light.	E. N. E. & W. light.
February	67·5	73·7	61·3	12·4	0·25	E. N. E. light.	W. N. W. light.
March	74·0	81·7	66·4	15·3	—	N. E. light.	W. & N. W. fresh.
April	74·4	82·2	66·7	15·5	Two light showers	N. E. light.	W. light..
May	73·9	80·6	67·3	13·3	0·16	W. N. W. & S. W. fresh.	W. N. W. & S. W. fresh and strong.
June	66·3	69·3	63·4	5·9	32·03	S. W. high & fresh.	S. W. high & fresh.
July	64·9	65·6	63·2	3·4	118·60	S. W. strong.	S. W. strong.
August	65·3	66·9	63·8	3·1	75·91	S. W. high.	S. W. high.
September	65·0	66·4	63·6	2·8	65·97	S. W. fresh.	S. W. fresh.
October	65·5	69·4	61·7	7·7	9·29	N. E. fresh.	N. E. & S. W. light E. N. E. fresh.
November	63·5	69·5	57·5	12·0	—	E. N. E. high.	E. N. E. fresh.
December	62·3	68·4	56·2	12·2	One light shower.	E. N. E. fresh.	E. N. E. & W. light.
Mean	67·3	72·1	62·6	9·5	302·21		

Hence it appears that the mean temperature of 1834 was 67·3 Fahr., that of the hottest month (April) 74·4, that of the coldest month (Dec.) 62·3; the mean maximum (April) 82·2, and the mean minimum (Dec.) 56·2. The mean variation was greatest in April, 15·5, and least in September, 2·8; and the mean variation for the year was only 9·5. The fall of rain was prodigious, being equal to 25 feet 2 inches, and this enormous mass of water fell almost entirely in the months of June, July, August and September. General Lodwick, late president at the court of Sattarah, who transmitted to me the official register, says, "I send to you a copy of Dr. Murray's meteorological table. The inches of rain are no less than 302·21. This will astonish the philosophers, but it would do more than astonish them, had they the opportunity of seeing and hearing the rain fall in torrents through a dense fog or mass of clouds which lie upon the ground for perhaps six weeks together, with a temperature by no means cold, and with little variation." The excessive fall of rain along the line of the Ghâts does not seem to be incompatible with health, for the military detachment stationed permanently at Mahabuleshwar is not characterized by any unusual sickness; and the statistical returns of the population on the hills are as healthy as those of the table-lands to the eastward. It now remains to notice some striking facts on the western side of the peninsula. The quantity of rain that falls differs exceedingly between the coast, the Ghâts within fifty miles of the coast, and the table-land eastward of the Ghâts. The mean at Bombay is 80·69. Dr. Murray shows a fall in the hills, at the elevation 4500 feet, of 302 inches, and my records at Poonah give a mean annual fall of 23·43 inches. The solution of the causes of the anomalous fall of rain does not offer any considerable difficulties. The enormous mass of vapour taken up from the Indian Ocean on approaching India, does not appear to have its upper surface at a greater elevation than five or six thousand feet, while the stratum is of great thickness; and I can bear testimony to its lower surface being below fifteen or eighteen hundred feet. The temperature of the air over the equator is necessarily very high, and its capacity for the support of aqueous vapour is proportioned to its temperature. The vapour is converted into rain, as it is driven into air of lower temperature; and, as the temperature gradually lowers proceeding to the north, and approaching the land, it follows, that out at sea, and along shore, with equal supplies of vapour, a less quantity of it would be converted into rain eastward. With respect to the prodigious fall at Mahabuleshwar and along the Ghâts, it may be accounted for by the supposition that the monsoon vapour being of low elevation and high temperature, is driven against the mural faces, and up the chasms

of the Ghâts, into higher regions, and into a colder atmosphere, and is thus immediately converted into rain. The paucity of rain forty or fifty miles eastward of the Ghâts, results from the comparatively small quantity of vapour which escapes from the cold belt of air through which it is forced to pass in the hills.

X.—*Proceedings of the Madras Literary Society and Auxiliary of the Royal Asiatic Society.*

Thursday Evening, 1*st October* 1840.—A. D. Campbell, Esq., *President of the Committee of Papers, in the Chair.*

The following works, presented to the Society, were laid before the meeting, and thanks voted to the donors :—

Journal of the Royal Asiatic Society of Great Britain and Ireland, No. 11—By the Society.

Journal of the Asiatic Society of Bengal, No. 15—By the Society.

The India Journal of Medical and Physical Science, No. 57—By the Editor

The India Review and Journal of Foreign Science and the Arts, No. 53—By the Editor.

The Chinese Secret Triad Society of the Tien-ti-Huih, 22 copies—By the Royal Asiatic Society of Great Britain and Ireland.

Thursday Evening, 5*th November* 1840—J. Cadenhead, Esq. *in the Chair.*

The following works, presented to the Society, were laid on the table, and thanks voted to the donors :—

The Vishnu Purana, 4 copies—By the Madras Government.

Journal of the Asiatic Society of Bengal, Nos. 16 and 17—By the Asiatic Society.

Corbyn's India Review and Journal of Foreign Science and the Arts, for September and October 1840—Nos. 54 and 55—By the Editor.

Corbyn's India Journal of Medical and Physical Science, Nos. 58 and 59—By the Editor.

McClelland's Calcutta Journal of Natural History, Nos. 2 and 3—By the Editor.

The Chinese Repository for May and June 1840—By the Editor.

Thursday Evening, 3d December 1840—*Doctor* R. WIGHT, *in the Chair.*

The following works, presented to the Society, were laid on the table, and thanks voted to the donors :—

Journal of the Asiatic Society of Bengal, No. 18—By the Asiatic Society.

The India Journal of Medical and Physical Science, No. 58—By the Editor.

The India Review and Journal of Foreign Science and the Arts, No. 55—By the Editor.

The Chinese Repository, Nos. 9 and 10, January and February, 1840—By the Editor.

Horary Meteorological Observations made agreeably with the suggestions of Sir JOHN HERSCHEL,

1*st.—At the Madras Observatory on the* 21*st September* 1840.

1840.	Time.	Barometer.	Thermometer.		Direction of wind.	REMARKS.
			Dry.	Wet.		
Sept. 21	6 A.M.	29,864	79,2	0,6	S S W	Breeze wind, cloudy.
	7	29,876	79,7	0,4	S W	Do. do. zenith clear
	8	29,900	81,7	0,7	S E	Do. do. do.
	9	29,912	83,8	2,9	S	Fresh wind, do.
	10	29,900	85,3	4,6	W	Do. do. flying clouds.
	11	29,898	86,4	6,5	W	Do. do. do.
	12	29,864	88,2	8,7	W	Do. do. do.
	1 P.M.	29,834	87,5	7,1	E	Do. do. do.
	2	29,810	88,0	6,5	E	Do. do. do.
	3	29,790	87,1	5,6	S E	Strong wind do. and thunder.
	4	29,818	83,2	6,2	N N W	Cloudy and very loud thunder with drizzling rain.
	5	29,778	79,6	3,6	S W	Cloudy.
	6	29,804	80,0	2,7	——	Calm, clear.
	7	29,815	80,2	2,2	S E	Very clear.
	8	29,840	80,3	2,3	S E	Do. do.
	9	29,868	80,2	1,9	——	Calm, clear, lightning and dew.
	10	29,882	79,8	1,6	——	Do. zenith clear, do. do.
	11	29,886	80,8	2,1	——	Do. flying clouds do. do.
	12	29,870	82,3	2,8	S	Gentle wind fl. cl. overcast lightning and thunder.
	1 A.M.	29,836	79,9	1,9	S	Do. do. cloudy thunder and lig.
	2	29,834	79,9	2,3	S	Do. do. do. loud thunder and vivid lightning.
	3	29,812	76,9	1,7	S	Do. do. do do. do. do.
	4	29,814	77,3	2,3	S	Do. do. do. thunder and lightng.
	5	29,820	77,0	2,6	S S W	Do. do. do.
22	6	29,832	76,9	1,1	S W	Do. do. do.
	7	29,874	77,0	1,7	——	Calm do.
	8	29,880	79,7	3,5	S W	Fresh wind do.
	9	29,876	81,0	2,3	W	Do. do. do.
	10	29,880	83,8	4,3	W	Do. do. zenith clear and some haze in south.
	11	29,870	85,1	6,1	W	Do. do. haze.
	12	29,840	86,1	7,6	W	Gentle wind, clear.
	1 P.M.	29,800	87,8	8,3	E	Gentle breeze, do.
	2	29,774	88,0	8,5	E	Do. do. do.
	3	29,764	88,2	8,2	W S W	Gentle wind, flying clouds.
	4	29,758	86,5	5,2	S W	Flying clouds.
	5	29,756	84,8	3,8	S W	Do. do. thunder.
	6	29,765	84,0	3,4	S W	Cloudy.

2d.—*At the Trevandrum Observatory at the Winter Solstice* 1840.

Date.	Hour.	Newman's Portable bar. corrected for temp. 32° and for capillarity.	Standard thermometer.	Depress. of wet bulb. thermometer.	Dew point.	Direction of wind.	Velocity of the wind.	Solar radiation.	Clouds, aspect of the sky and remarks.
Dec. 21	6 A.M.	29·756	68·6	8·0	55·00	N.	6	No observations.—On account of Actinometer being out of order.	Sky clear gentle wind.
	7	·782	68·4	8·1	54·50	do.	4		Do. do.
	8	·803	73·5	9·8	57·30	N. by E.	5		Do. do.
	9	·818	77·8	13·4	55·50	NE. by N.	5		Light clouds rising up do.
	10	·822	80·9	16.3	53·40	NE. by E.	3		Do. do.
	11	·802	82·4	17·5	52·90	NN. W.	4		Sky rather clear do.
	Noon.	·771	83·5	17·0	55·40	do.	3		Do. do.
	1 P.M.	·747	84·3	17·2	56·10	N. by E.	1		Do. wind hardly perceptible.
	2	·722	84·8	17·7	55·70	SE.	3		Do. gentle wind.
	3	·710	84·0	15·9	58·30	S.	4		Light clouds do.
	4	·709	82·8	15·5	57·60	SS. W.	3		Do. do.
	5	·722	81·5	13·7	59·40	S.	3		Do. do.
	6	·744	79·5	12·4	59·40	SS. W.	2		Zenith clear, rest cloudy, wind just perceptible.
	7	·769	78·5	10·6	61·56	W.	1		Sky clear light air.
	8	·794	75·4	9·4	60·17	ES. E.	1		Do. do.
	9	·808	74·9	9·2	60·00	SE.	2		Cumuli about horizon rest cl. do.
	10	·811	71·0	6·3	60·77	E.	2		Do. do. do.
	11	·804	69·4	5·4	60·60	do.	3		Sky clear gentle wind.
	Mid.	·792	68·9	2·0	65·73	do.	3		Do. do.
„ 22	1 A.M.	·782	68·0	1·9	64·96	—	—		Do. calm.
	2	·766	67·0	3·9	60·62	E.	3		Do. cold wind.
	3	·748	66·3	3·7	60·24	do.	4		Do. do.
	4	·743	65·5	3·9	59·10	do.	5		Do. pleasant wind.
	5	·749	65·6	3·9	59·20	W.	3		Do. gentle wind.
	6	·777	64·9	3·8	58·60	—	—		Do. haze about horizon, calm.
	7	·792	66·2	3·8	60·00	—	—		Do. do, do.
	8	·811	71·8	7·2	60·09	N.	3		Light clouds in the zen. cum. about horizon gentle wind.
	9	·820	77·2	11·0	59·30	do.	1		Sky clear light air.
	10	·810	80·8	14·3	57·40	N. by E.	3		Sky pretty clear gentle wind.
	11	·792	82·5	13·9	60·30	NN. W.	2		Do. wind just percept.
	Noon.	·757	84·4	15·7	59·20	do.	2		Do. do.
	1 P.M.	·730	85·6	18·9	54·20	do.	2		Sky covered with light clouds do.
	2	·706	85·6	14·3	63·53	W.	5		Do. do. pleasant wind.
	3	·693	84·6	14·8	61·24	do.	3		Do. do. gentle wind.
	4	·692	84·3	14·3	61·81	do.	3		Do. do. do.
	5	·703	83·0	12·9	62·97	W. by S.	2		Do. do light air.
	6	·743	80·3	11·0	63·02	S. W.	2		Do. do. do.

No Rain.

The Instruments are the same, and situated exactly as before.

G. SPERSCHNEIDER, *Superintendent*

METEOROLOGICAL REGISTER KEPT AT THE MADRAS OBSERVATORY; FOR THE MONTH OF JULY, 1840.

Days.	Barometer at			Ther. at			Wet Bulb.			Rain.		Evaporation.	Strength of wind.	Direction of Wind.			Cloudy Max.	Weather.		Remarks.
	10 A. M.	4 P. M.	10 P. M.	10 A. M.	4 P. M.	10 P. M.	10 A. M.	4 P. M.	10 P. M.	Sun-rise.	Sun-set.			10 A. M.	4 P. M.	10 P. M.		10 A. M.	4 P. M.	10 P. M.
1840	Inch.	Inch.	Inch.	o	o	o	o	o	o											
July 1	29,856	29,758	29,820	88,6	90,3	86,8	10,6	9,1	9,9	......	......	3,665	2	N W	E S E	S E	3	Clear	Clear	Clear—lightning.
2	,840	,748	,820	87,7	90,4	86,3	8,7	10,4	5,8	......	......	......	2	W	E	S E	2	Fl. cl.	Clear	Clear do. Rainbow to the w.
3	,878	,799	,890	88,0	90,0	88,0	8,5	8,5	6,9	......	......	......	2	S E	E N E	S E	3	Fl. cl.	Fl, cl.	Haze do.
4	,908	,800	,892	87,9	88,8	87,9	5,5	8,6	6,0	......	0,017	......	2	E S E	E by S	S E	3	Fl. cl.	Clear	Th. hz. do.
5	,882	——	,844	80,5	—	86,1	7.4	—	6,1	......	......	......	2	N W	——	E	5	Fl. cl.	——	Cloudy do. [and lightning.
6	,846	,743	,818	84,4	86.0	84,4	5,0	4,5	4,3	0,105	0,024	......	2	N W	Calm	S W	4	Cloudy	Cloudy	Fl. cl. Rainbow to the w. Th.
7	,836	,750	,812	82,8	86,4	85,3	4,3	7,4	3,3	......	......	......	2	W	W	S	4	Cloudy	Cloudy	Cloudy lightning.
8	,842	.750	,814	83,9	85,0	84,3	4,4	5,5	4,8	......	......	3,068	2	W	Calm	S W	7	Cloudy	Cloudy	Cloudy drizzling rain lightning.
9	,862	,790	,874	84,3	86,0	85,0	3,8	10,6	10,5	......	......	......	2,3	W N W	N W	W N W	8	Cloudy	Cloudy	Cloudy lightning.
10	,866	,780	,852	85,7	87,8	83,8	12.2	14,0	5,8	......	......	......	3	W N W	N W	N	9	T. haze	Cloudy	Cloudy drizzling rain lightning.
11	,850	,745	,812	85,5	88,0	84,5	8,5	15,0	9,9	0,005	......	......	4	W	W	N W	9	Cloudy	Cloudy	Cloudy lightning.
12	,756	——	,750	86,0	—	83,9	11,1	—	6,4	......	......	......	2,3	S W W	——	N	9	Cloudy	——	Cloudy do.
13	,786	,706	,802	87,2	91,3	89,2	11,6	15,8	7,4	......	......	......	2,3	S W W	N W by W	S	7	T. haze	Cloudy	Cloudy Rainbow to the east.
14	,878	,750	,854	88,6	92,0	86.8	13,2	13,5	8,0	......	0,345	......	2,3	W	S E	S W	6	T. haze	Cloudy	Th. hz. lightning. [strong wind.
15	,862	,738	,806	87,8	89,4	87,8	10,9	8,6	7,3	......	......	2,301	3	W	S S E	S	8	Haze	Cloudy	Th. hz. Th. and lightn. very
16	,816	,690	,790	85,5	89,7	84,8	5,7	8,7	6,3	1,214	0,147	......	2,3	S W	S	S W	7	Cloudy	Cloudy	Cloudy thunder and lightning.
17	,796	,724	,786	85,8	89.0	85,5	9,9	10,3	10,5	......	......	......	2,3	S W W	S. S E	S W	7	Cloudy	Cloudy	Cloudy lightning.
18	,806	,684	,798	86,9	90,3	85,9	10,5	12,6	7,3	......	......	......	2,3	S W	Calm	S W	8	Fl. cl.	Cloudy	Cloudy thunder and lightning.
19	,794	——	,783	85,3	—	82,7	6,8	—	2,1	0,557	0,035	......	2,3	S W	——	S W	8	Cloudy	——	Cloudy lightning.
20	,770	,688	,808	83,6	82,0	82,4	6,7	4.0	4,0	......	1,392	......	2	S W	N W.	S W	8	Cloudy	Cloudy	Cloudy do.
21	,796	,724	,810	81,7	83,2	81,7	5,5	6,2	5,2	0,467	......	......	2	S W	S. S W	S W	8	Cloudy	Cloudy	Cloudy do.
22	,806	,722	,804	81.9	86,2	84.1	6,5	9,2	6,6	......	......	2,131	2	S W W	S W	W	8	T. haze	Cloudy	Cloudy do.
23	,830	,710	,804	83,9	88,3	85,2	7,5	9,5	5,3	......	......	......	2,3	S W	S W	S W	8	T. haze	Cloudy	Cloudy do.
24	,814	,690	,790	85,2	90,2	85,9	9.4	14,2	6,4	......	......	......	3	W	S W	W	7	T. haze	Cloudy	Cloudy do.
25	,810	,706	,842	84,6	88,2	87,2	9,6	11,2	11,6	0,049	......	......	3	W	Calm	W	7	Cloudy	Cloudy	Cloudy do. strong wind.
26	,874	——	,846	86,6	—	89.2	12,1	—	10,2	......	......	......	2,3	W	——	N W	7	Haze	——	Haze do.
27	,886	,776	,850	87.7	90,8	88,6	8,4	15,8	14,3	......	......	......	2.3	W	W	W	7	Haze	Cloudy	Haze do.
28	,858	,744	,808	87.4	91,3	86.1	12,3	12,0	5,7	......	......	......	2,3	W N W	S E	S	5	Clear	Cloudy	Clear do.
29	,848	,733	,814	87,9	88,5	86,4	10,5	9,0	8,3	......	......	3,638	2,3	N W	S E	S	6	Clear	Cloudy	Cloudy do.
30	,830	,718	,808	86,8	89,0	88,3	7,9	11,6	7.8	0,067	......	......	2,3	W	S E	S	5	Haze	Cloudy	Fl. cl. do.
31	,848	,748	,850	88,4	88,0	86.2	12,0	8,5	5,2	......	......	......	2,3	W	S E	S	6	Haze	Cloudy	Fl. cl. do.
Mean.	29,836	29,738	29,821	85,7	88,4	85,8	8,6	10,2	7,1											

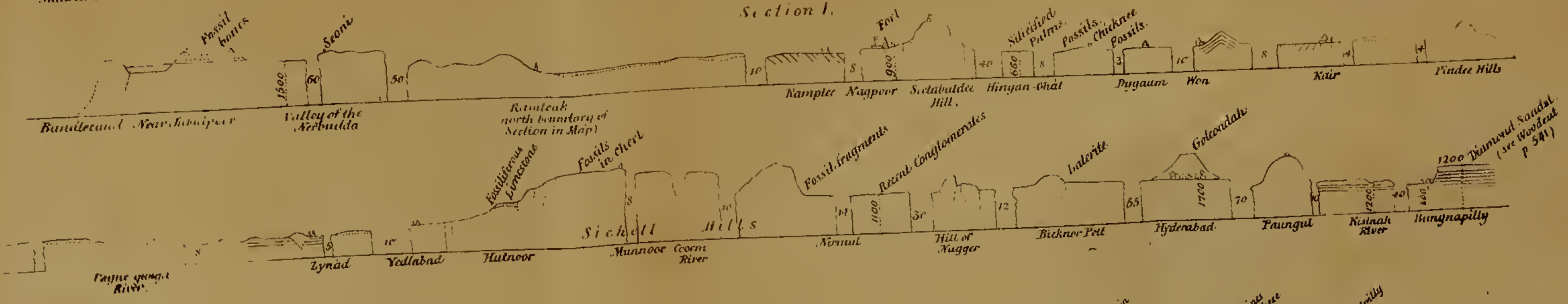
Meteorological Register kept at the Madras Observatory; for the Month of August, 1840.

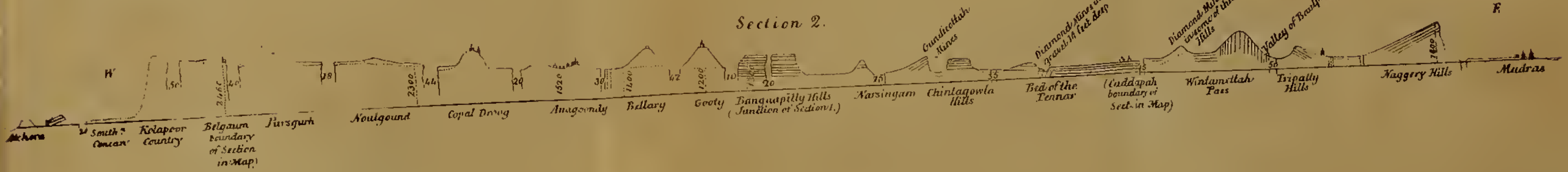
Days.	Barometer at 10 A. M.	Barometer at 4 P. M.	Barometer at 10 P. M.	Ther. at 10 A. M.	Ther. at 4 P. M.	Ther. at 10 P. M.	Wet Bulb. 10 A. M.	Wet Bulb. 4 P. M.	Wet Bulb. 10 P. M.	Rain. Sun-rise.	Rain. Sun-set.	Evaporation.	Strength of wind.	Direction of Wind. 10 A. M.	Direction of Wind. 4 P. M.	Direction of Wind. 10 P. M.	Cloudy Max.	Weather. 10 A. M.	Weather. 4 P. M.	Remarks. 10 P. M.
1840	Inch.	Inch.	Inch.	o	o	o	o	o	o											
Aug. 1	29,870	29,748	29,874	86,2	92,0	85,8	10,3	15.0	6,4	......	0,117	......	2,3	W	S S W	S	7	Haze	Cloudy	Cloudy—Thunder and lightn.
2	,878	———	,850	85,5	—	85,9	7,6	—	5 9	0,909	......	......	2,3	W	———	S W	6	Clear	———	Cloudy th. and lightn. Rainbow
3	,854	,760	,848	85,0	86,0	83,1	8,0	8,0	5,6	......	......	......	2,3	W	W by N	S W	8	Cloudy	Cloudy	Cloudy lightn. [in the evening.
4	,838	,720	,798	85,4	88,0	85,6	6,9	10,0	7,1	......	......	......	2,3	W	S W by W	S W	6	Cloudy	Cloudy	Cloudy do.
5	,848	,734	,810	84,5	90,0	86,3	9,8	13,0	7,7	......	......	......	2,3	W	W by N	Calm.	6	Haze	Cloudy	Cloudy do.
6	,838	,704	,800	86,0	92,0	86,3	10,9	15,5	5,8	......	......	1,802	2,3	W	W S W	N W	7	Haze	Cloudy	Cloudy do.
7	,798	,700	,800	87,1	92,0	88,8	11,1	15,0	8,7	......	......	......	2,3	W	W	S E	6	Th. ha.	Cloudy	Cloudy do.
8	,858	,744	,856	86,9	93,0	88,6	7,4	16,0	7 7	......	......	......	2,3	W	W	S W	5	Th. ha.	Cloudy	Cloudy do.
9	,896	———	,856	87,2	—	87,4	10,3	—	4,4	......	......	......	2,3	W	———	S	4	Haze	———	Cloudy do.
10	,880	,748	,824	88,2	88,3	85,9	11,7	9,3	5,7	......	......	......	2,3	N W	S E E	S	3	Clear	Clear	Haze do.
11	,870	,774	,860	88,0	89,8	85,0	11,4	10,3	6,0	......	......	......	2,3	W	S S E	S	3	Fl. cl.	Clear	Haze do.
12	,890	,778	,888	86,9	89,0	85,8	9,6	8,5	6,3	......	......	......	2,3	N W	S E	S	5	Clear.	Clear	Fl. cl. do.
13	,912	,800	,888	87,9	88,8	87,9	8,4	7,0	6,9	......	......	3,628	2,3	W	S E	S	4	Clear	Clear	Fl. cl. do.
14	,908	,760	,848	86,1	90,0	87,0	7,4	10,0	5.5	......	......	......	2,3	S W	E	S	3	Clear	Clear	Th. hz. do.
15	,874	,774	,872	88,2	90,0	88,2	12,6	10,0	6.1	......	......	......	2,3	N W	S E	S	4	Haze	Haze	Th. hz. do.
16	,910	,830	,912	89,0	90,0	88,2	13.0	10,0	6,7	......	......	......	2,3	W	S E	S	4	Haze	Haze	Fl. cl. do.
17	,910	,780	,852	89,0	90,0	87,9	11,0	9,5	6.8	......	......	......	2,3	S W	S S W	S	8	Haze	Haze	Th. hz.—vivid lightning.
18	,880	,764	,856	84,9	89,4	86,4	7,4	9,6	5,3	......	......	......	2,3	N W	E	S	7	Cloudy	Cloudy	Cloudy lightning.
19	,864	,788	,832	86,4	88,2	86,8	11,0	8,7	6,5	......	......	......	2,3	W	E by S	S	5	Th. ha.	Cloudy	Cloudy do.
20	,890	,802	,856	86,5	89,0	85,7	10,5	9,3	5,7	......	......	3,026	2,3	N W	E by S	S E	5	Th. ha.	Cloudy	Clear do.
21	,896	,784	,870	87,2	88,8	87,7	9,0	9,5	7,2	......	......	......	2,3	W	E S E	S	7	Th. ha.	Clear	Fl. cl. do.
22	,876	,763	,854	87,7	89,2	86,8	8,6	9,2	7,9	......	......	......	2,3	S W	———	S	4	Fl. cl.	Clear	Cloudy drizzling rain & lightn.
23	,878	———	,850	85,3	—	86,7	5,9	—	3,1	0,437	......	......	2,3	S W	E by S	W	6	Fl. cl.	———	Clear lightning.
24	,892	,774	,922	85,5	88,0	85,1	6,5	7,0	4,7	......	......	......	2,3	W	S E	S E	7	Clear	Clear	Cloudy do.
25	,904	,783	,856	85,0	88,2	87,0	2,5	7,7	4.4	0,287	......	......	2,3	W	S	S E	4	Haze.	Cloudy	Cloudy vivid lightning.
26	,878	,743	,822	83,6	88,7	85,9	5,8	7,7	5,1	0,027	......	......	2,3	W	E	S E	6	Cloudy	Th. hz.	Haze lightning.
27	,854	,736	,842	85,4	88,0	87,3	6,4	7,0	5.8	......	......	2,331	2,3	S W	S	S	8	Haze.	Clear	Haze loud th. & vivid lightn.
28	,888	,762	,862	82,0	87,0	85,9	5,5	5,5	4,4	3,952	......	......	2,3	W	E S E	S	6	Cloudy	Clear	Cloudy do. do. do. do.
29	,866	,758	,854	83,2	86,0	84,8	4,2	5,5	3,4	2,091	......	......	2,3	N W	———	S	6	Cloudy	Cloudy	Haze lightning.
30	,824	———	,802	84,1	—	84,2	4,9	—	4,3	......	......	......	2,3	N E	S E	E	8	Cloudy	———	Haze do.
31	,800	,684	,822	84,8	86,0	82,6	4,3	5 0	4,2	......	......	......	2,3	S W	Calm	W	8	Fl. cl.	Cloudy	Rainy loud th. & vivid lightn.
Mean	29,872	29,759	29,851	86,0	89,1	86,4	8,4	9,6	5,8											

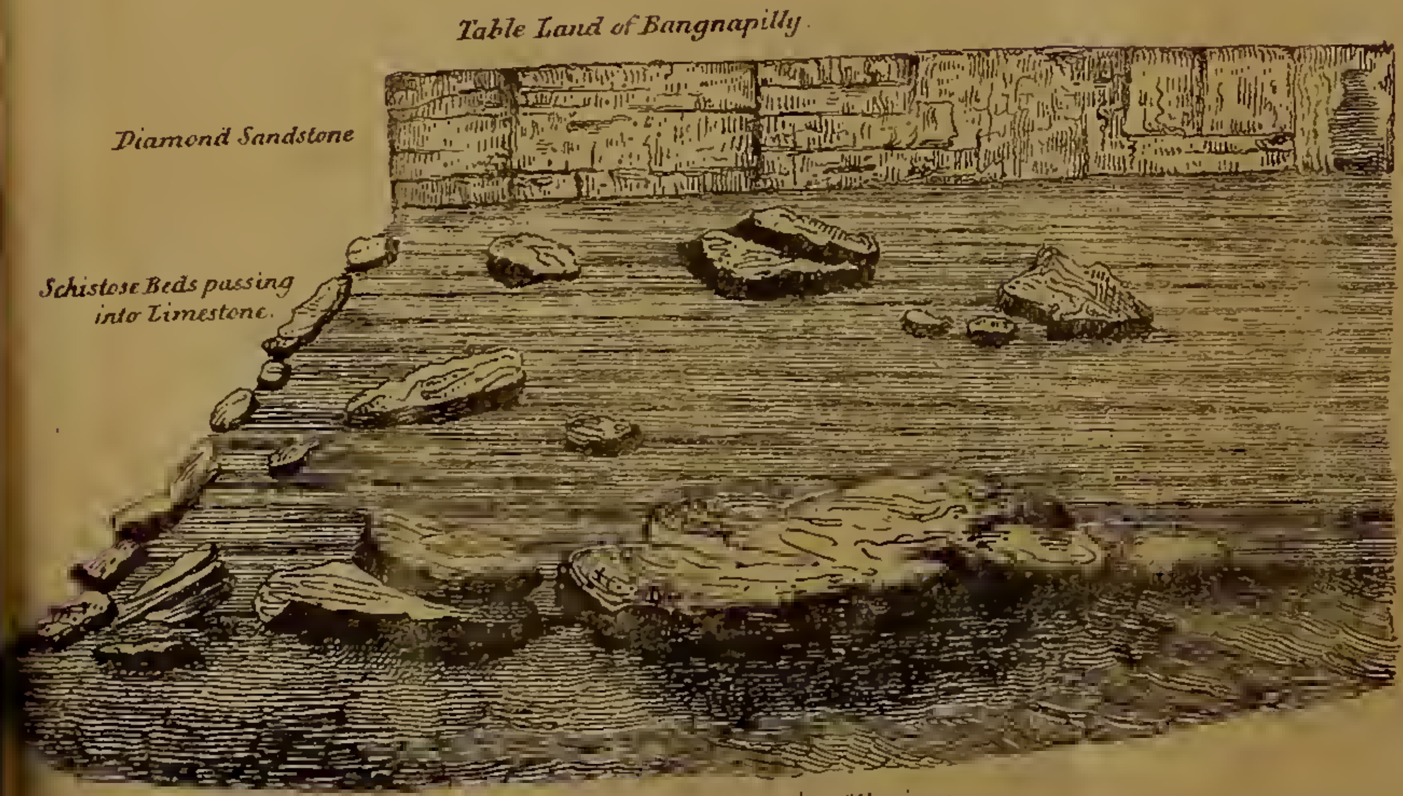
South-east Portion
of the
GREAT BASALTIC DISTRICT
of
INDIA.
to illustrate Mr. Malcolmson's memoir.
Diamond Sandstone. Argillaceous Limestone
Granite & Gneiss.
Mica, Chlorite & Hornblende Slates
Basalt
Laterite.
Alluvium.
Gawilgur (Fossils)
Narnulla
Ellichapoor
Ramteak
Kamptee
NAGPOOR
Kanhan R.
Taptee R.
Oomrawutty
Goomigaum
Takulghaut
Sindee
Poornah R.
Ackolah
Mallegaum
Adjuntah
Mahangaum
(Fossil Wood)
Hingan-ghat
Naugree (Fossil Shells)
Wurdah R.
Karinjah
Wurroorah
Jafferabad
Payne Gunga R.
Baussum
Ellora.
AURUNGABAD
Lonar
Rishwar
Tulnee
Jaulnah
Bandack
Chandah
Wonor Wunny
Hot Springs
Rajoorah
Sangaree
Adilabad
Beroor
Chicholy
Hingolee
Julny
Partoor
Ahoondah
Oomerkair
Hutnoor
Echodah
Surpoor
Mundwah
Bibberee
Goongee
Poornah R.
Warhona
Buswunt
Waddoorpett
Andkee
Kurrum R.
Nandair
Godavery R.
NIRMUL
Soorarum
Beer
Khair
Doodgaum
Godavery R.
Dharoor
Balcondah
Cotapilly
Siroacha
Indoor
Hurroolah
Chinnoor
Ramgheer
Lankulaguda
Kunamulla
(Petrified Wood)
Perricapoor
Dekarapully
Nagarum
Oodgheer
Owsah
Mulloopettah
Nuggur
Elgundel
Mullangoor
Rungapoor
Mungapett
Rajampetta
Koiwles
Kamahred
Bekanoorpetta
Vyrag
Byaram
Munnugore
Maiduck
Narsingumpett
Medecondah
Waringole
Ashwapoorum
(Hot Spring)
BEDER
Doopranee
Sholapoor
Punderpoor
Yellumpettah
Badrachellum
(Hot Spring)
Palensha
Gopaulrowpett
Godavery R.
Papcondah
Ahmedhal
Bougheer
Bolarum
Neercondah
Secunderabad
Gulburgah
Musy R.
HYDERABAD
Golcondah
Gungarum
Dunmapait
Gummamet
Shumshabad
Nelgoondah
Sooriapett
Chintalapoody
Gokdrum
Fossil Oysters
Rajahmundry
Ramsingarum
BEEJAPOOR
Juddacherlah
Yeedgherry
Dewurcaudry
Warrapilly Ghaut
Kistna R.
ELLORE
Condapilly
(Diamond Mines)
Bezwarrah
Amarawutty
Madapollam
Muctul
Ruckputtypett
Paungul
Tentelly
Ranchoor
GUNTOOR
MASULIPATAM
Belgaum
Kulladghee
MOODGUL
Innaconda
Toombudra R.
KURNOOL
Nargoond
Gudjunterghur
Adonie
Ongole
Noulgoond
Cumbum
Darwar
Hullial
Nundyall
Bangnapilly
Junction of Sections 1 & 2
Copper Mines
Nulla Mulla Hills
BELLARY
GOOTYDROOG
Paumoor
Yellapoor
Savanoor
Gundycottah
Soonda
Penaur R.
Diamond Mines
Guncoopa
Durmawaram
CUDDAPAH
NELLORE
Honhully
Ryachottee
Section 2
CHITTLEDROOG
Niddigul
Transfer by J. Dumphy.
Printed by W. Winchester.

BRITISH MUSEUM
NATURAL HISTORY

Madras Jour. Lit. & Science, Vol XII, Pl. VI.



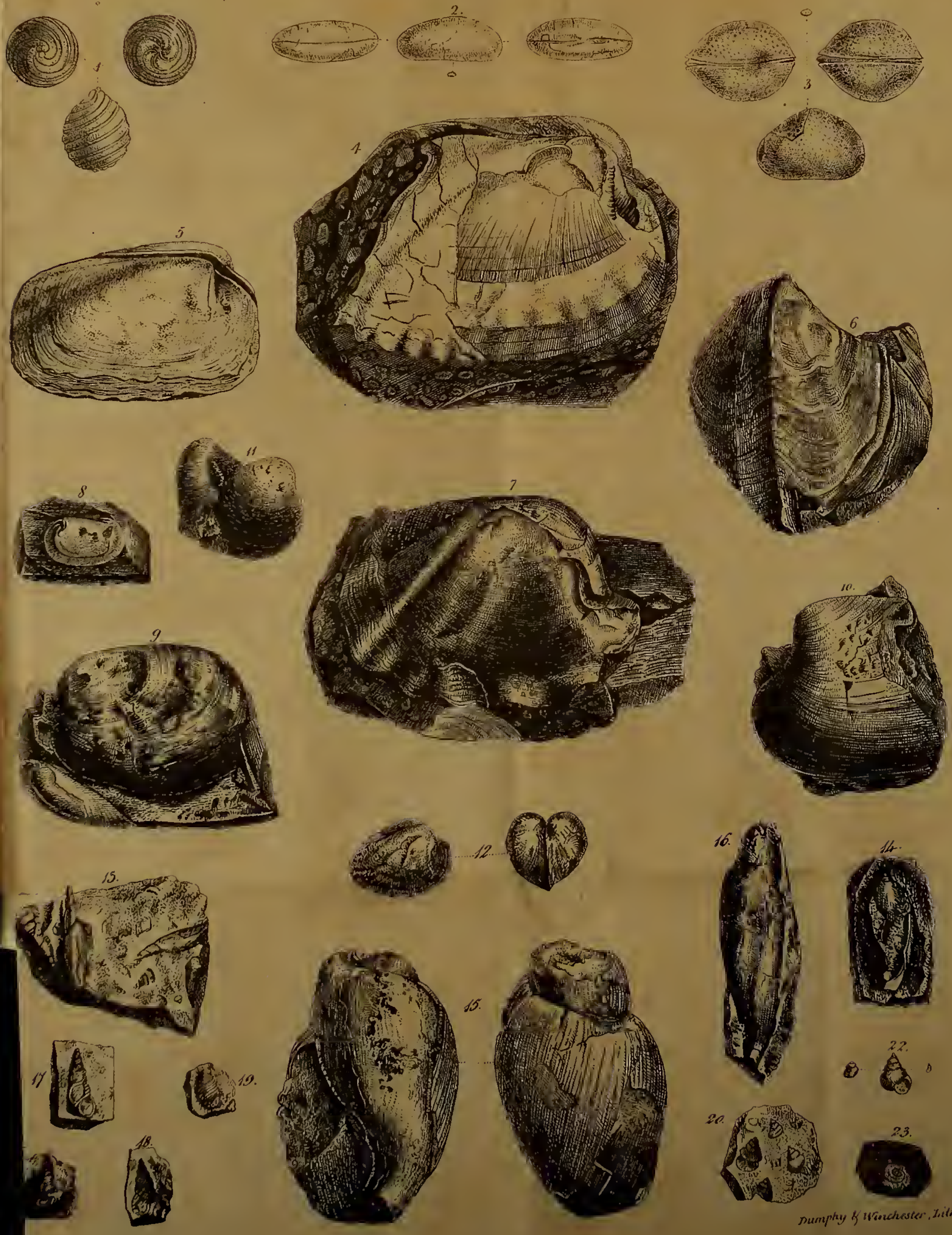




Diamond Mines in Alluvium

BRITISH MUSEUM
NATURAL HISTORY

SOUTHERN INDIA.
(See Mr. Malcolmson's Memoir.)



Dumphy & Winchester, Lith.